POPULAR SCIENCE

FOUNDED MONTHLY 1872

JUNE

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See Page 41

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Plymouth's low center of gravity, rigid frame, sway eliminator and shock-proof steering add still more steadiness.

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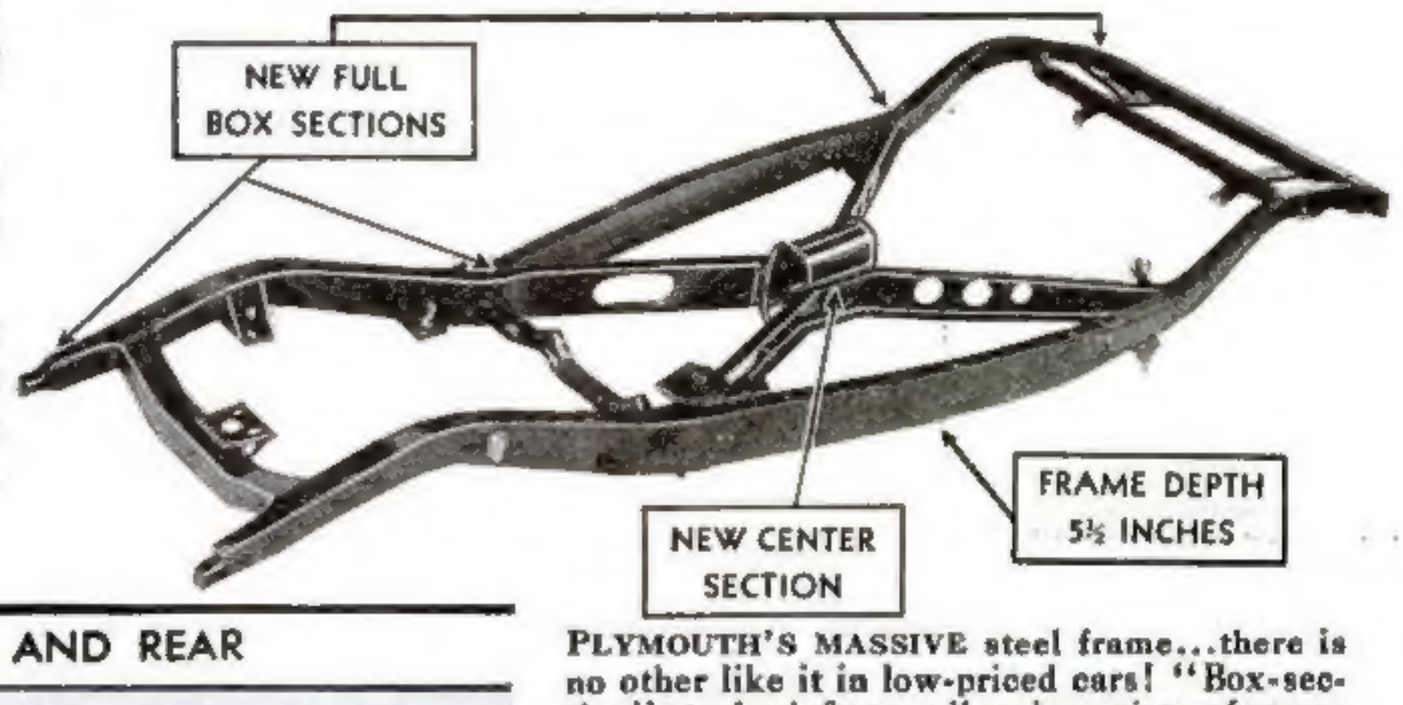
Find out for yourself...drive this new Plymouth. See your Chrysler, Dodge or De Soto dealer. Only $510 and up...list at factory, Detroit (special equipment extra).

PLYMOUTH DIVISION OF CHRYSLER CORP.

INSIST ON 100% Hydraulic brakes. Always equalized...they STOP quick and sure.



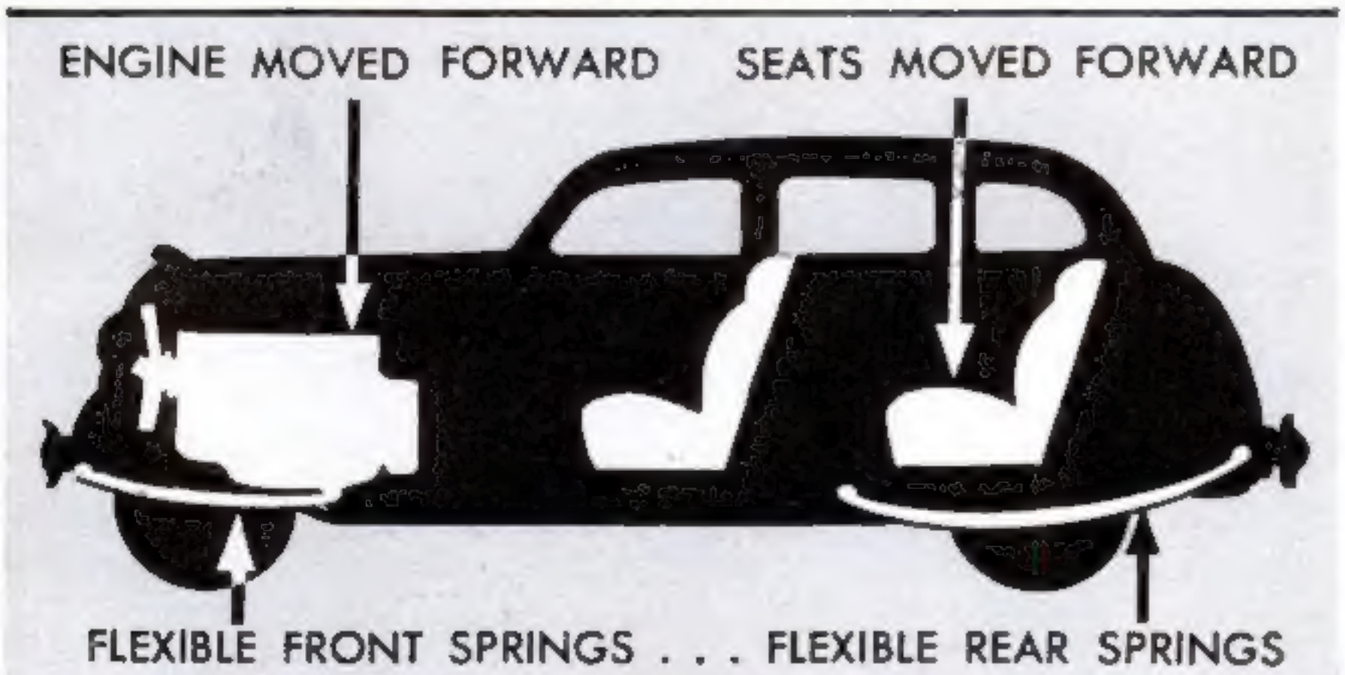
PLYMOUTH'S MASSIVE steel frame...there is no other like it in low-priced cars! "Box-section" steel reinforces all major points of stress in this twice-as-rigid "X" frame...giving added strength and protection in the new Plymouth.

(*Left*) DIAGRAM SHOWS Plymouth's correct weight distribution. Balanced weight plus synchronized spring action are big factors in giving Plymouth a truly "Floating" ride...making it the easiest riding of "All Three."

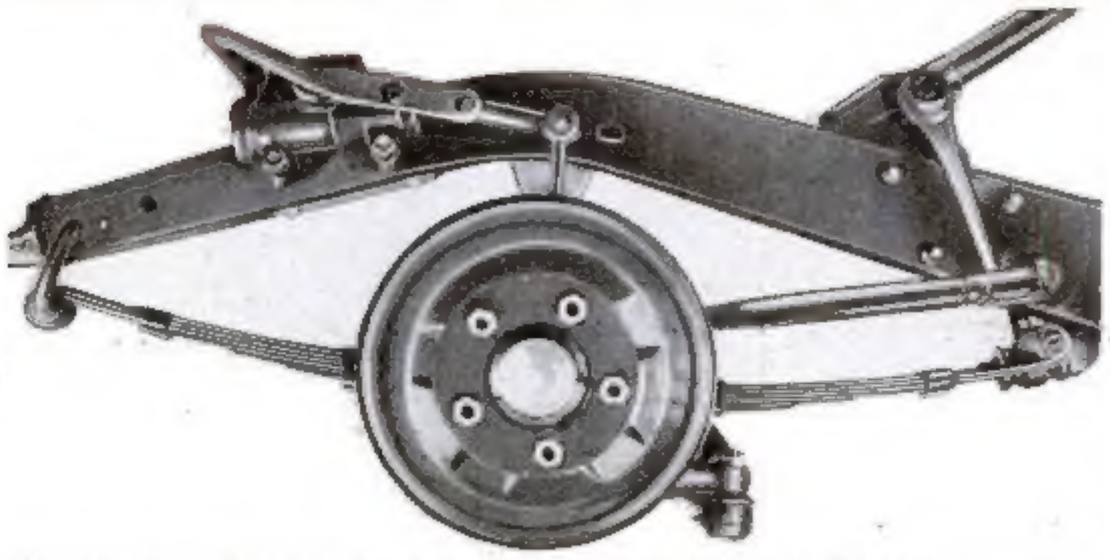
EASY TO BUY

Plymouth is priced with the lowest... and Plymouth terms are as low as the lowest! You can buy a big, new Plymouth for as little as $25 a month with usual down payment. The Commercial Credit Company has made available to all Chrysler, Dodge and De Soto Dealers low finance terms that make Plymouth easy to buy.

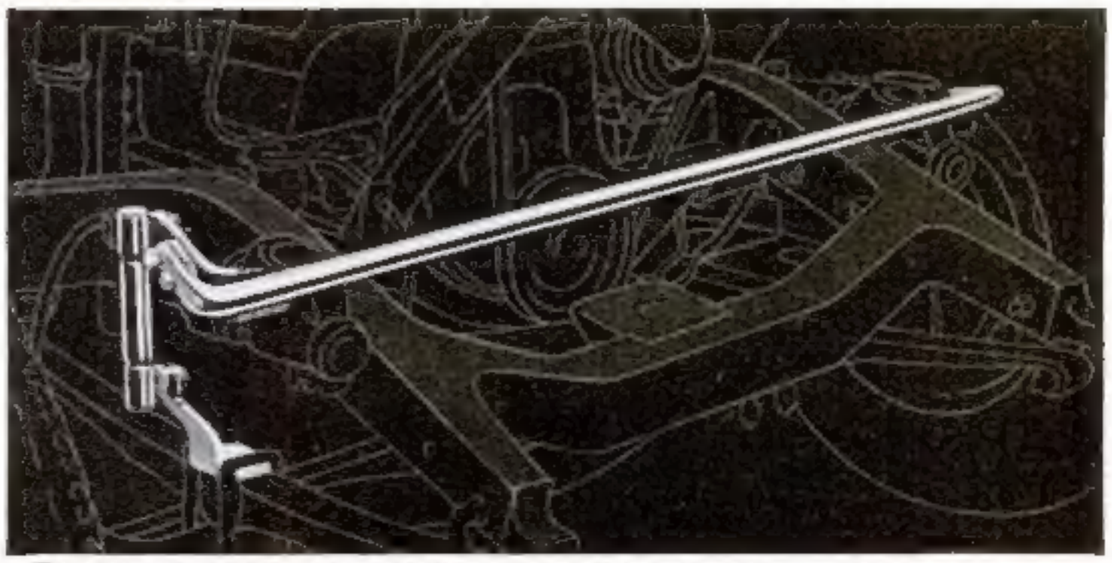
EQUAL WEIGHT FRONT AND REAR



SPRING ACTION IS SYNCHRONIZED



PLYMOUTH'S NEW steering anchors spring and drag link at rear.



SWAY ELIMINATOR reinforces weighted spring—keeps car even.

RAYMOND J. BROWN, *Editor*
ARTHUR WAKELING, *Home Workshop Editor*
ALDEN P. ARMAGNAC, *Associate Editor*
SYDNEY OXBERRY, *Art Editor*

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FEATURES AND DEPARTMENTS

Cover Design by EDGAR F. WITTMACK

AUTOMOBILES

AVIATION

POPULAR SCIENCE MONTHLY FOR JUNE, 1936

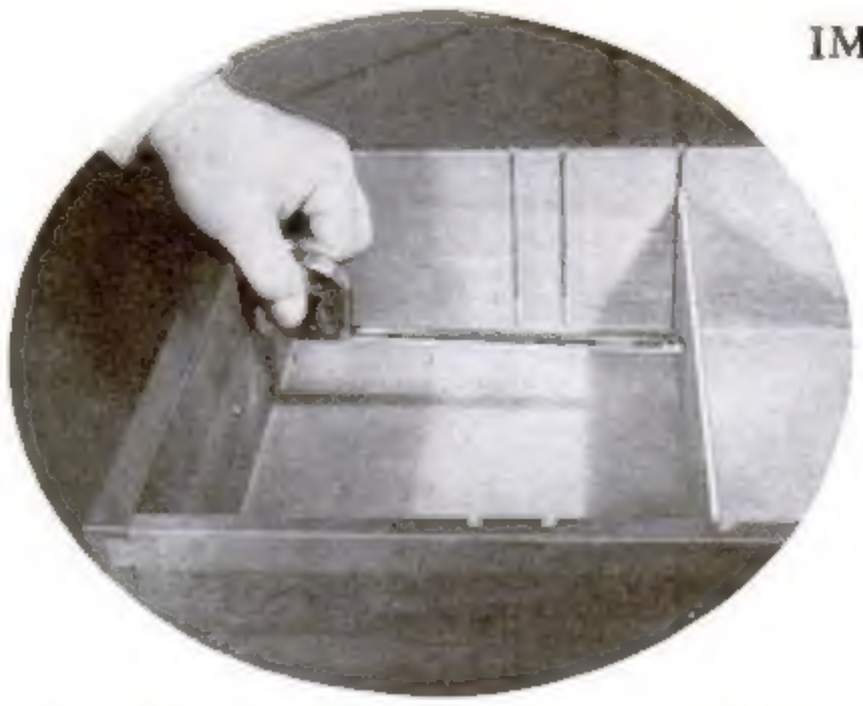
In This Issue—Hundreds of Fascinating Articles Tell the Latest News of Laboratory Discoveries, Scientific Triumphs, and Amazing New Inventions

Home Repair Aids
FOR THE HANDY MAN

TILE-PATCHING CEMENT

WITH a quick-drying cement made especially for the purpose, it is a simple matter to mend cracked or chipped wall tiles. Hardening to a white, porcelain-like finish, it is applied with a brush in thin coats. In patching a chipped surface, several coats must be applied to build up the surface the required amount. Broken tiles can be mended by applying a thin coat of the cement to the edges and pressing the pieces together. According to the manufacturers, the cement also is excellent for filling crevices or cracks between bathtubs and tile walls.

Cracked bathroom tile being patched with cement. Put on with a brush, it hardens to a white finish



Tape case held against inside edge of space being measured, giving reading on the face of the blade

IMPROVED STEEL TAPE

A NEW variation of the familiar steel roller tape makes it easy to take inside measurements quickly. The square backedge of the case is simply placed against one side of the opening being measured; the rule blade extended to the limit; and two inches, the exact length of the case, added to the reading indicated on the tape. A hook at the end aids in taking outside measurements.

PREVENTS STICKING WINDOWS

WINDOW sash or doors treated with a new preparation will never bind or stick, according to the manufacturer. Because it traps the natural moisture in the wood and excludes outside dampness, wood so treated will never warp, twist, or rot, it is claimed. As shown in the photograph at the right, a complete window can be treated by immersing it in a large can of the solution. This preservative treatment of wooden parts and structures does not affect or require any change in the method of applying paints and enamels.

SCREW DRIVER HAS TWO-ENDED BLADE

HAVING a double-ended blade, the screw driver shown above will fit a larger variety of screws than the ordinary type of tool. If one blade does not fit a particular screw, the shank can be pulled from the handle and quickly reversed to bring a different size blade into play.

Questions
FROM HOME OWNERS

Q.—HOW can I take the "knocks" out of my hot-water system? It has a tendency to be particularly noisy when the heater is forced.—H. A. P., Plainfield, N. J.

A.—ANY water-heating system is likely to knock when it is overheated. Steam forms rapidly and causes the noise. Don't force your heater, it is dangerous. If it knocks even when heated moderately, some peculiarity in the piping system or clogged piping probably is causing the trouble.

TRACING ROOF LEAKS

F. R. Y., DALLAS, TEX. Roof leaks can be traced quicker from inside than from the outside. Look for water stains and then inspect the inner roofing around the highest point of the stain. Once the leak is located, have a friend tap it gently with a hammer while you trace the spot by "feeling" for the tap from the outside. Right after a heavy spring rain is an ideal time to carry on your investigation.

CURING SWEATING PIPES

P. F., HARRISBURG, PA. The only sure cure for sweating pipes is to cover them with insulating material. This will prevent the moist air from reaching the pipes and eliminate any possibility of condensation.

BLOTTER CLEANS WALL PAPER

Q.—HOW can I remove a few large grease spots from wall paper? The paper is light in color and was applied less than a year ago.—T. N., Richmond, Va.

A.—MOST grease spots will yield to a pad of blotting paper pressed against the wall with a moderately hot iron. After most of the grease has been extracted by the blotter, dampen the spots, sprinkle on a little powdered pipe clay or fuller's earth, allow it to dry, and remove with a soft brush.

REVARNISHING OLD WOOD

G. D. F., SEATTLE, WASH. A successful revarnishing job can only be obtained by carefully cleaning the surface before applying the new finish. A solution of sal soda in water will do the trick. One varnish coat generally is enough for refinishing work.

PAINTING MARBLE FIREPLACE

Q.—I HAVE a marble fireplace that I would like to modernize with paint. How can I make the paint stick? It has a tendency to crawl.—S. C. A., Philadelphia, Pa.

A.—THE marble first must be cleaned thoroughly to remove all grease. Wash it well with soap and water and then rub it briskly with a cloth soaked in benzene.

ADDING NEW CONCRETE TO OLD

E. F. G., SAN FRANCISCO, CALIF. When cementing new concrete to old, rough up the old surface, wet it down thoroughly, and then apply a wash coat of pure cement paste. New concrete can be placed against this with little danger of cracking.

ORDINARY SALT KILLS GRASS

D. S., TRENTON, N. J. A generous application of ordinary table salt to the cracks in your flagstone walk will prevent grass from springing up between the sections. One dose, early in the season, should last all year.

CRAFTWORK KITS SAVE YOUR TIME

KIT Q

This is the privateer *Swallow*, a model with 12½-in. hull

MUCH of the satisfaction in building ship models as a hobby arises from the fact that there are so many beautiful models from which to choose. You can advance step by step from small, highly simplified models such as those listed below under the headings "Model-of-the-Month Kits" and "Simplified Ship Model Kits" to the more elaborate and valuable models described under the heading "Standard Ship Model Kits."

Among the latter is one exceptionally fine model which should appeal to those who wish to do an advanced piece of work, yet do not care to undertake too large or intricate a model. It is the *Swallow*, a two-masted Baltimore clipper used as a privateer in the War of 1812. Although it is a true scale model in every sense of the word, it is relatively small—20 in. long and 13½ in. high over all. It is so graceful in design, so perfect in all details, that the most experienced model makers will find it an appealing project, yet it is not too complicated for craftsmen of limited experience. The construction kit contains the four hull pieces or "lifts" sawed to shape and all the necessary raw materials, together with three sheets of blueprints and instructions.

If you prefer a later type of clipper, there are three kits to choose from—the *Great Republic* (Kit 4S), the *Sovereign of the Seas* (Kit V), and a much simplified model of the famous *Sea Witch* (Kit J).

The complete list of our kits follows. Bear in mind that these are not factory-made kits, but special assortments of selected materials prepared by hand as a service to readers who wish to save themselves the trouble of shopping around for the often hard-to-get supplies needed in making projects of this type.

STANDARD SHIP MODEL KITS

A. Whaling Ship *Wanderer*, 20½-in....$7.40*
D. Spanish galleon, 24-in..... 6.95*
E. Battleship U.S.S. *Texas*, 3-ft..... 7.45*
G. Elizabethan galleon *Revenge*, 25-in. 7.25*
L. Farragut's flagship *Hartford*, steam-and-sail sloop-of-war, 33½-in. hull..... 8.45*

(Continued on page 7)

KIT aM—Ocean freighter, 14 in. long

OUR CONSTRUCTION KITS

(Continued from page 6)

KIT J—*Sea Witch*

Q. Privateer *Swallow*, 12½-in. hull.....$4.95†
V. Clipper *Sovereign of the Seas*, 20½-in. hull ..... 4.95†
Y. Trading schooner, 17½-in. hull..... 4.90†
2S. U. S. Destroyer *Preston*, 31½-in. hull, ... 5.95*
3S. *Constitution* ("Old Ironsides"), 21-in. hull 6.50*
4S. Clipper ship *Great Republic*, 31½-in. hull 8.40*

SIMPLIFIED SHIP MODEL KITS

F. Liner S.S. *Manhattan*, 12-in..... 1.00
H. Cruiser U.S.S. *Indianapolis*, 12-in. 1.50
J. Clipper ship *Sea Witch*, 13-in..... 1.50

MODEL-OF-THE-MONTH KITS

M. Aircraft carrier *Saratoga*, 18-in..... 1.00
N. Four U.S. destroyers, each 6¼-in. .75
O. Liner S.S. *St. Louis*, 11-in..... 1.00
R. U. S. cruiser *Tuscaloosa*, 11¾-in... 1.00
U. *Hispaniola*, the ship in "Treasure Island," 7-in. ..... .50
Z. H.M.S. *Bounty*, 11½-in..... 1.50
1M. Show boat, illuminated, 14-in..... 1.50
2M. Ocean freighter, 14-in..... 1.50
3M. Yacht *Nourmahal*, 8⅛-in..... 1.00

MISCELLANEOUS

No. 4. Solid mahogany book trough 22½ in. long, 9½ in. wide, and 24¾ in. high over all. Ready to assemble, with finishes..... 5.30*

NO. 5

No. 5. Solid rock maple hanging wall rack with one drawer, 19½ in. wide, 33¼ in. high. Ready to assemble and stain included..... 5.75*

No. 7. Whittling kit with two shaped blocks for making sea captain 5½ in. high. A knife, three bottles of paint, pocket sharpening stone, and instructions are included..... 1.50

No. 8. Whittling kit for six different Scotties. Each is 2 by 2¼ in., sawed to shape. Paint, paintbrush, instructions, etc..... 1.00

NOTE: If you live west of the Mississippi River or in Canada, add 50 cents to all prices marked with an asterisk (*) and 25 cents to all prices marked with a dagger (†).

Popular Science Monthly,
353 Fourth Avenue, New York, N. Y.

Please send me C. O. D. Kit.....

I will pay the postman the price shown above plus a few cents postage in full payment. (Canadian orders cannot be sent C. O. D.)

Name .....

Address .....

City ..... State.....

(Print name very clearly.)

If you prefer to send your remittance with this order, we will pay delivery charges. Remit by money order, check, or registered mail. This offer is made only in the United States and Canada.

Our Readers Say

All Set To Go Hunting For Microbes

I'M NOT asking for anything new. I just want more of the old stuff. M.R.S., of Winnipeg, Canada, took the words right out of my mouth when he requested more articles by Dr. Damrau and some covering more advanced chemistry. In addition, let's have a series on amateur bacteriology. Back in 1934, Mr. Walling wrote an article on microbe hunting. I believe a large number of readers are interested in this field of science and would profit by an article which included the identification of bacteria by their reactions to solutions of different sugars. In conclusion, let me say I've enjoyed every number of your magazine for the last four years.—J.W.J., Springfield, Ill.

There Are Good and Bad Snakes, Reader Reminds Us

I AM something of an amateur ophiologist and, in my study of snakes, I have been struck by the needless destruction of beneficial species by farmers and suburbanites. There is no doubt that this world would be a better place to live in if such creatures as rattlesnakes and moccasins were removed, but there is no reason why we cannot spare the harmless members of the reptile family. Man's loathing for these creatures is acquired from his fellows, not instinct as some would have us believe. Most people are uninformed about the habits and usefulness of some of our common serpents. Few know that the corn snake crawls into the burrows of field mice and eats the young or that the king snake destroys its venomous cousins. This information is easily obtainable and the agricultural departments of most states will furnish pamphlets on the subject.—H.B., Jr., Wilmette, Ill.

Does Not Relish Thought Of Man-Made Volcanoes

SOME time ago I read in your magazine that the Russians had succeeded in igniting coal in its natural mine beds in such a manner as to generate illuminating gas which was piped to storage tanks. More recently I have read that they propose to do a similar thing with a sulphur mine—burn the pyrite ore and pipe the sulphur gases to the surface where they will be converted into sulphuric acid. If this labor-saving idea spreads, will the engineers and scientists be able to control these man-made volcanoes, for that is what they really amount to? A wild oil gusher would be just a playful spring in comparison to one of these volcanoes on a rampage.—O.M.M., Sacramento, Calif.

Expert Sleeper Offers Services to Science

AFTER reading your May issue, I have decided that I may be of some value to the world, after all. On pages 11, 12, and 13, you have pictures of people snoozing for dear old science, while "delicate instruments" record their dreams of riding the shoot-the-chutes at Coney Island. Then, on page 17, you have another human guinea pig snatching forty winks while a couple of playful Ph.D.'s set off alarm clocks, loudspeakers, and (possibly) firecrackers to see whether loud noises are conducive to sound slumber. If all the laboratories are being turned into dormitories, there must be a considerable demand for really first-class sleepers as subjects, and I am herewith volunteering my services. If I do say it myself, my mastery of the art of sleeping comes close to real genius; my best friends say it is the only thing I really do well. Any scientist who is looking for a subject to do either plain or fancy sleeping can communicate with me. Straight salary basis. No extra charge for dreams.—J.B., New Orleans, La.

Glass Airplane Would Be Its Own Camouflage

JUDGING from recent articles in POPULAR SCIENCE MONTHLY, I'd say we are entering the "Age of Glass." Even now we have glass clothes, glass houses, glass that eliminates headlight glare, glass furniture, and glass nuts and bolts. It's a wonder to me that some trail-breaking inventor hasn't proposed a glass airplane with wings and fuselage of sheet glass and glass cloth. Such a plane would have a decided advantage in warfare; it would be practically invisible at a height of a few thousand feet.—H.W., Baltimore, Md.

In Other Words, He Favors An Amateur Standing

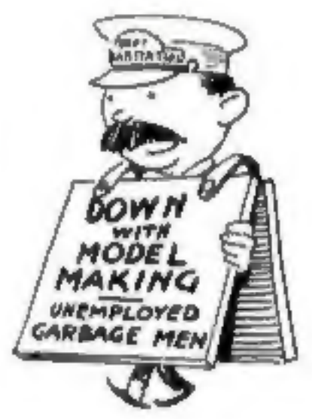
HAVING been a reader of your magazine for some time, I want to say that I think it is the berries as it is. Some people will holler their heads off for more advanced articles, but those people can get magazines devoted entirely to their hobbies. I feel that P.S.M. should be a magazine for the all-around amateur and not for the professional. And I want it to be a man's magazine.—F.O.F., Indian Head, Md.

Fair Reader Would Compromise Chemistry Question

THERE are few subjects more fascinating than organic chemistry and many interesting compounds in this field are not difficult to prepare. So I, for one, heartily endorse the suggestion of F.E.C., of Newport, Vt., that you should publish articles on organic chemistry. Why not run them alternately with your present series—simple experiments one month and more advanced, including organic preparations, the next? I am sure such a scheme would be approved by most chemistry enthusiasts.—(Miss) C.C., Hove, England.

Even Old Tennis Shoes Can't Escape Model Makers

BEING an amateur astronomer and "weather bug," I particularly like the articles by Gaylord Johnson and Edwin M. Love. I have also constructed a model of the clipper ship *Sovereign of the Seas*. During this model-building work, I hit upon a little trick which may be helpful to other readers. I discovered after drilling the holes for the hawse pipes that they would not appear realistic if left as they were. So I removed a pair of large eyelets from an old tennis shoe and straightened them out. Next I gave them the proper oval shape and pressed them into the hawse holes, using a drop of glue to hold each in place. After they were painted and the anchor chains inserted, these details looked very shipshape.—D.K.K., Glen Head, N. Y.



Giving Plenty of Color To His Radio Programs

A FRIEND and I recently finished building the color organ described in the April issue of your magazine. While we did not conform strictly to the specifications, the organ performs quite satisfactorily and we are more than pleased with it. The outfit is housed in an old midget radio cabinet and, as an improvement, we inserted a volume control in the circuit. If there were some way of slowing the response of the bulbs to the variations in tones, the apparatus would function perfectly. The one at A Century of Progress in Chicago responded in this manner. As a suggestion for a companion article to that on the color organ, could you give us one on the building of an electronic organ, to be used alone or with the color organ?—J.P.S., Reed City, Mich.

Using Watch for Compass, It's Hour Hand That Counts

IN EXPLAINING the method of using a watch as a compass, R.H.L., of Denver, Colo., made an incorrect statement in a letter to Our Readers Say a few issues ago. He said that if you point the hour hand to the sun, then halfway between the minute hand and twelve on the dial is south. The fallacy of this direction can be seen if you consider that the minute hand may be anywhere at a given time and the halfway point is just as likely to point north as south. R.H.L. should

have stated that after pointing the hour hand directly at the sun, then halfway between the *hour* hand and the numeral twelve is south. —M.M.O., West Springfield Pa.

Ventriloquist Speaks For Himself and Fencing

IN THE April number, G P.R., of Roanoke, Va., asks for an article on fencing. Having been a fencing student for almost a year, I heartily agree with this suggestion and would like to see an article on the subject. I also hope you grant the request of J.H.O., of Ottawa, Canada, for an article and plans for making a ventriloquist's doll. I have constructed marionettes from your plans and every one, without exception, has been very satisfactory.—W.K., Reading, Pa.

Back Numbers Bring Back Fond Memories

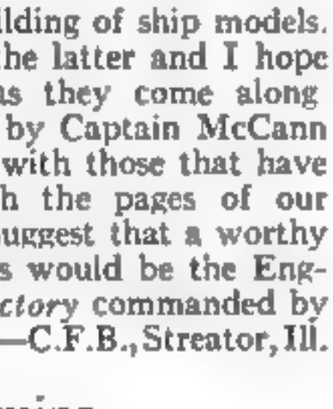
I SPENT a very enjoyable evening several weeks ago reminiscing by paging through some old copies of POPULAR SCIENCE MONTHLY—1926 issues to be exact. All of which leads to the reason for this letter. Why not start a monthly feature entitled "Popular Science Twenty Years Ago," and reprint, original cuts, type, and all, the most interesting article that appeared in the corresponding issue twenty years ago? Every one likes history and what could be more interesting than such a background of present-day science?—J.S., Albany, N.Y.

Nominates Nelson's Flagship For Modeler's Hall of Fame

ALTHOUGH I enjoy all the articles in your magazine from cover to cover, those which claim most of my attention are the ones on home repairs and the building of ship models. I have built several of the latter and I hope to continue to do so as they come along Since the ships designed by Captain McCann seem to deal principally with those that have sailed gloriously through the pages of our history, I would like to suggest that a worthy companion to these ships would be the English battleship H.M.S. *Victory* commanded by Admiral Horatio Nelson.—C.F.B., Streator, Ill.

When We Go Steaming Through the Stratosphere

THE steam-car fan who bemoaned in a recent letter the fact that the steam engine was cast aside in the development of the automobile may be heartened by a recent report from Russia. Aviation experts there have come to the conclusion that the low efficiency of the gasoline engine in rarefied air is the chief obstacle to airplane travel in the stratosphere. The use of superchargers offsets this difficulty to a certain extent, but these experts believe their use will not afford a satisfactory solution to the problem. They think that the steam engine gives the answer because it operates with about constant efficiency regardless of surrounding air pressure. Research has been started which they hope will lead to the development of a suitable stratosphere airplane steam engine. Maybe, and with a touch of irony, steam will supplant gasoline in the swift stratosphere flyers of the future—R.T., Dallas, Texas.



Wants To Become A Collector of Wooden Guns

I AM an ardent reader of your magazine and wouldn't miss an issue for the world With its help, I am able to keep track of what is going on all about me. I have a request I hope you will grant in some future issues. I would like to see plans for making actual-size, wooden models of famous army rifles, such as, our own Springfield, Britain's Enfield, and Germany's Mauser. I believe many readers would be interested in making such a collection.—G.M., Burlington, Vt.

Bicyclist Seeks Plans For Wheel Generator

You seem to be willing to give helpful hints to the owners of automobiles and to radio fans so I am going to take a chance and ask you to give a thought to the fellow who rides a bicycle. What I have in mind is that you run an article telling how to build a six-volt generator with an output of five amperes at 750 r p.m. and which is compact enough to be installed on a bicycle. Such a generator would be less expensive in the long run than batteries and it would do away with the annoyance of finding that your batteries are dead—usually on some night when you need them most.—J.N K., St. Paul, Minn.

Why Build Boats? Asks Model Railroader

How about more articles on model railroads? Last year there was a lot about this type of model building. It was good stuff. It helped me to build a top-notch model railroad easily and inexpensively. All I find nowadays on model building are boats—boats here, boats there, and most of them only good to look at. They are too hard to construct, anyway. If you would revive some R. R. business, I would be very grateful.—M M O., Jr., Boston, Mass.

Steam Cars, He Says, Can Stage No Comeback

As I was reading the letter sent in by F.L.G., of Birmingham, Mich., I could not decide whether he was serious or not. I can't imagine anyone wishing to have the steam car return. F.L.G. mentioned that a steam car had been driven 120 miles an hour as early as 1907. This car, no doubt, was a specially built racing model and ordinary factory jobs of the same type could not attain this speed. We all know that Sir Malcolm Campbell recently drove his racer at a speed of more than 300 miles an hour and that this car was driven by a gasoline engine! As for Martin Bunn's reference to steam vehicles, I believe he was pointing out only one feature of such cars and I doubt if Gus himself would even consider the feasibility of developing the steam-driven automobile.—R.W.H., Holland, Mich.

Thinks Bees' "Ideal" Home Would Get All Gummed Up

REPLYING to E.W., of St. Louis, Mo., relative to a model beehive, I disagree with him in regard to a six-inch clearance space around the frames. First of all, when honey would be coming in, this space would be full of burrcomb and honey which would upset his air-conditioning idea. Second, with the hive covered with burrcomb, it would be impossible to examine the frames. Third, in most states it is illegal to have a hive in which the frames cannot be moved, which would ultimately be the case with E W.'s hive. In general, the commercial beehive, I believe, is hard to beat. Leaving the subject of bee keeping, I would like to see a few more articles on how to photograph wild animals.—H.B., Cape May Court House, N J.

A Ready Disciple Of the Glass-Blowing Art

ALTHOUGH my interests range through a variety of subjects such as radio, machine-shop practice, woodworking, movie making, astronomy, and chemistry, I have always found P.S.M. to be a fine companion. One subject I should like to see covered is glass blowing. This is an interesting art and the type of article I have in mind is one which would enable the home-workshop enthusiast to make glass objects, particularly glassware that is needed in laboratory work. —K.S., Edmonton, Canada.

He'd Raise the Bridges Out of Flood's Reach

THE recent floods in this area have caused me to ponder over our method of bridge construction. Maybe my thoughts, like some bridges, lack a solid foundation but here they are. Why not construct small and medium-size bridges of aluminum or one of its alloys, following a girder design similar to that employed in building dirigibles? With this greatly reduced weight, it would be possible from a cost standpoint, I reason, to have them operate on the jackknife or elevator method. During a flood most of the bridge structure could be raised, giving a clear passage to the rushing, debris-laden waters. I think it would be the best kind of insurance that bridges would withstand floods and, if used only once in ten years, the added cost would be well spent. The cost of replacing two destroyed bridges which I have seen will be very high and this expense comes at a time when neither the towns or state have any surplus funds. To this loss add the unknown cost to merchants and townspeople and the total reaches a huge sum of money. Possibly you or some reader has a better solution to the problem. If so, let's hear about it.—A.W.U., Pittsburgh, Pa.

Views Desert Skyscrapers As Mecca for Explorers

BACK in 1934, two French aviators flying over an unexplored area of the Arabian desert spotted what they thought were the ruins of the ancient capital of the Queen of Sheba. They reported seeing twenty or thirty high, white towers that appeared to be made of marble. The papers made quite a fuss about it at the time although no ground explorations could be made because of the hostility of the natives. I thought particularly of that story when I read the interesting item in your last issue about the "skyscrapers in the desert" at Shibam, in Arabia. Perhaps the airmen saw similar skyscrapers. The whitened, sun-baked clay of buildings like those at Shibam might easily be mistaken for marble, I should think, from an altitude of a few hundred feet. Be that as it may, the region should be a fascinating one for future explorers to investigate systematically, if the nomads who inhabit the little-known territory can ever be pacified.—G.J., Pittsfield, Mass.

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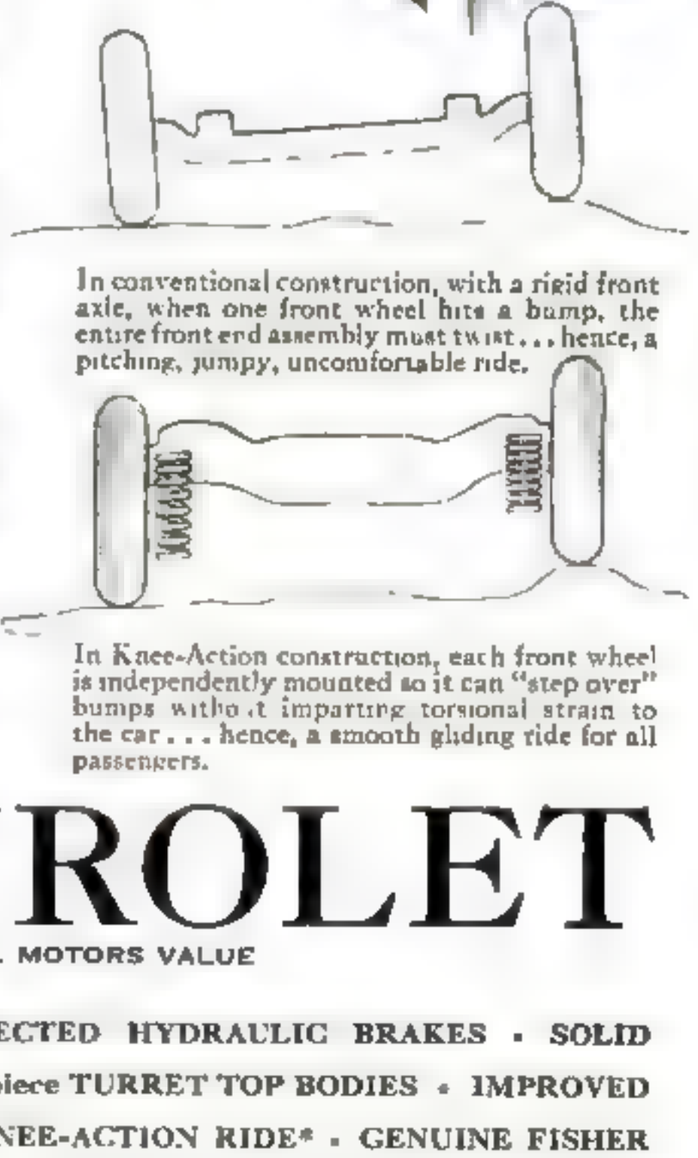

In conventional construction, with a rigid front axle, when one front wheel hits a bump, the entire front end assembly must twist . . . hence, a pitching, jumpy, uncomfortable ride.

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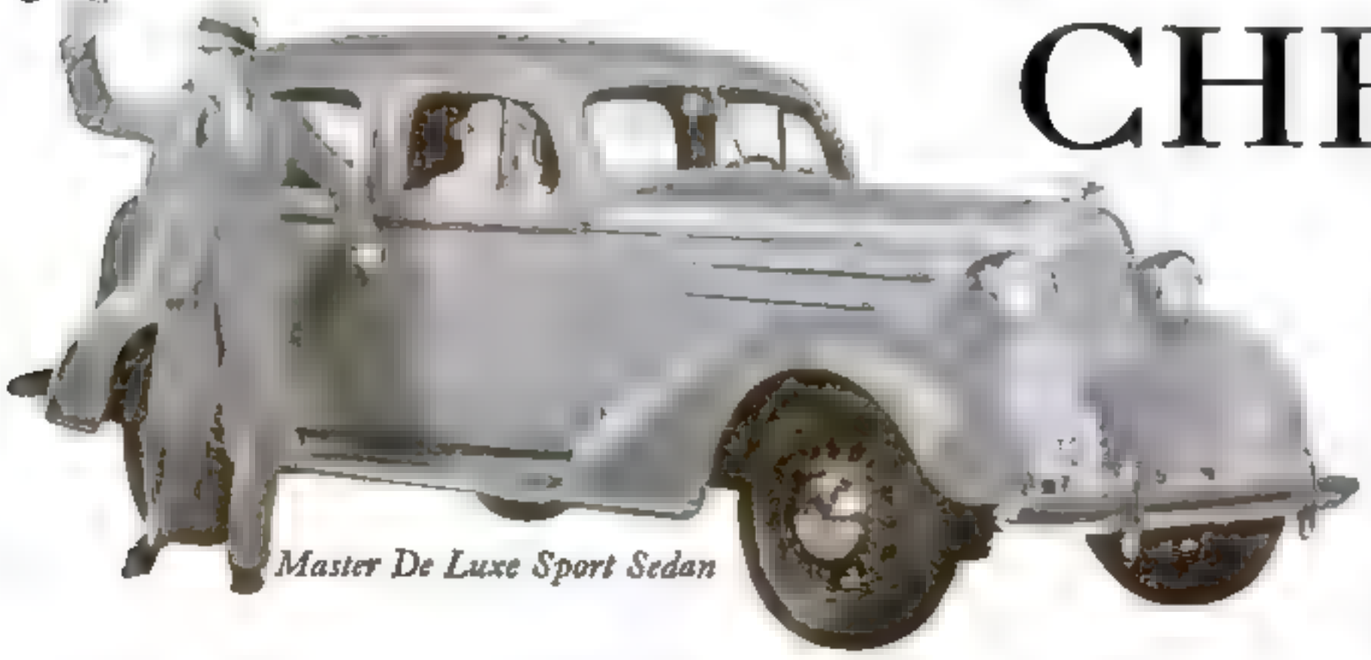

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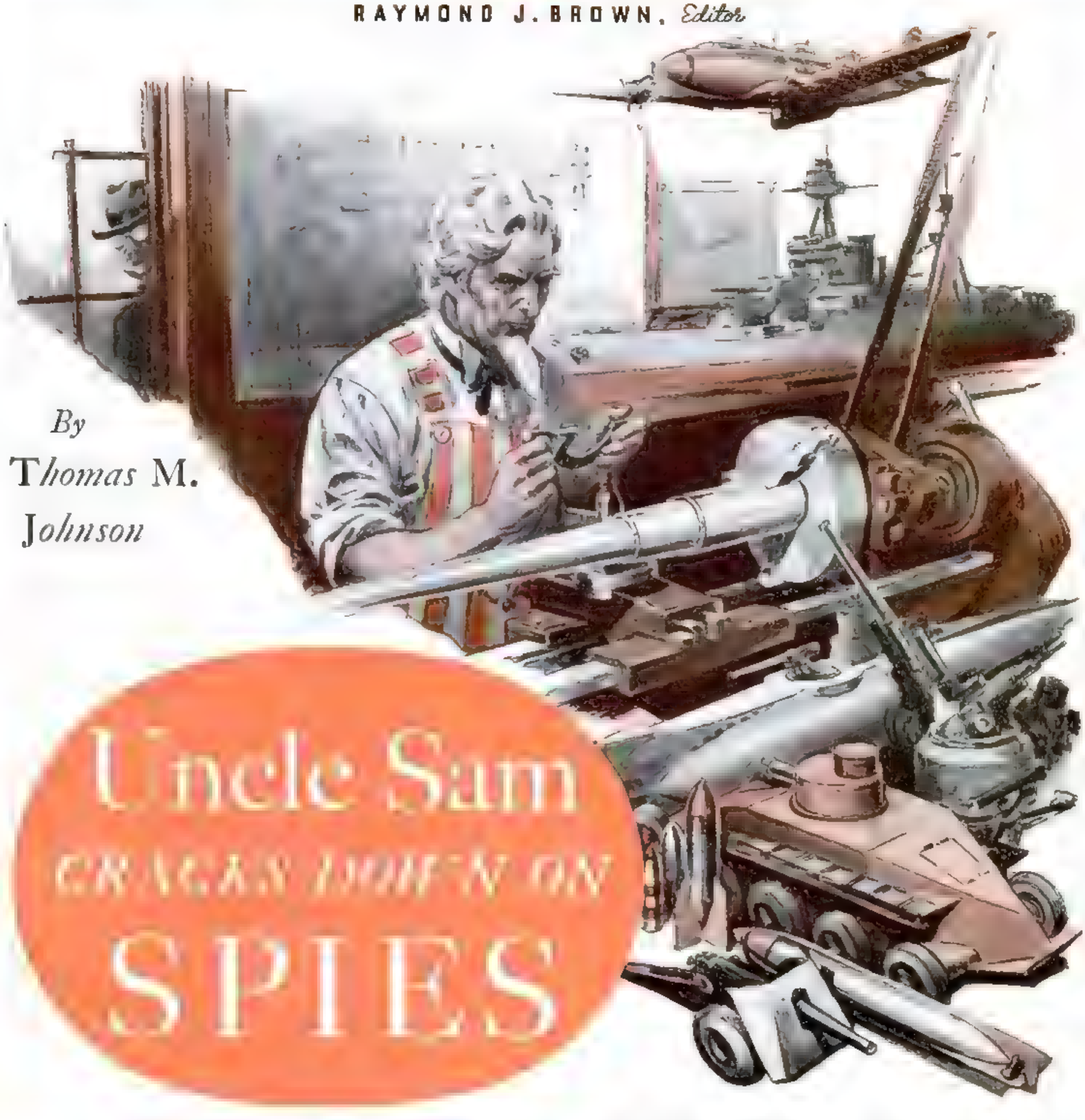
POPULAR SCIENCE Monthly

JUNE 1936 VOL. 128 No. 6

RAYMOND J. BROWN, *Editor*



By
Thomas M. Johnson

Uncle Sam CRACKS DOWN ON SPIES

...To Guard the Secrets of His War Machines

SCIENTIFIC spies for foreign powers are picking Uncle Sam's pockets. As war tension heightens abroad, more and more of them invade our shores. They sneak across the oceans from Europe, where last year $50,000,000 was spent on secret service, or from Asia, where Japan alone spent $12,000,000. These spies are no fools, fantastically disguised, whispering, scowling. They are intelligent men and women, using clever tricks to steal from this wide-open country the countless military appliances and inventions that American ingenuity produces. With our own weapons, pilfered from us, foreign powers are arming for the next war. For that purpose, the scientific spies lurk unsuspected in our midst.

Most Americans would be astounded if they knew what goes on beneath the lid that is clamped down on secret service. Spies? In the movies, perhaps, or over in Europe. But here, in America? It can't happen here! Well, let us lift the lid a little, to reveal the dark, unguessed, and startling plots and counterplots of real life, right here, today.

TRUE SPY STORIES, FILTERING THROUGH THE MASK OF SILENCE MAINTAINED BY GOVERNMENT AGENCIES, REVEAL A NETWORK OF ESPIONAGE DESIGNED TO FERRET OUT THE SECRETS OF OUR NATIONAL DEFENSE FOR FOREIGN POWERS

Last February, in Los Angeles, Calif., G-men quietly brought in a young man in the blue uniform of a Navy yeoman, with the roll of the sea in his gait. "Just impersonating a naval officer," said the G-men. But, they demanded $20,000 bail. Then they locked in the county jail another youth, whom they let no one see except officers from our great battleship fleet, then at anchor in Los Angeles Harbor. Finally, the G-men sifted through the city's Oriental quarter, but returned empty-handed.

The Federal Grand Jury began an investigation, and through its locked doors, oozed the sensational truth.

The first prisoner was suspected of being an American traitor, who had sold himself as a spy to a foreign power. Formerly a sailor, he had disguised himself in a naval uniform, visited battleships, stolen important papers. These gave secret plans for coming naval maneuvers, even movements of ships planned three months ahead; also, important data on recently developed aircraft equipment. The second prisoner was an important witness, held for safety. The twisting trail led to a master spy for a certain foreign power that takes great interest in our fleet. He eluded the G-men, and fled; but they are still after him, and they always get their man.

Even when he is a dead man. A body lay on a pallet in the back room of a tiny tavern in an American seaport. A sudden heart attack had caught the man, the medical examiner said

"No reason to suspect anything wrong, have you?" he asked the investigating police.

"Not a reason," a sergeant replied. "This guy kept this place for years. All the gobs from the naval base knew him. He hadn't an enemy."

Buzz! Buzz! Buzz!

The uniformed men started.

Buzz! Buzz! Buzz!

"My God, it's the corpse!" cried one. "The dead man's buzzing!"

But the sergeant sprang to the cot and lifted the body. He stretched a hand underneath the mattress, groped about. Then he brought forth a box.

Buzz! Buzz! Buzz!

In the box was a telephone. The policeman took the receiver off the hook. He heard a voice in a foreign language.

"Can you get this?" he asked the other men in the room. Nobody could. So the policeman shouted into the transmitter:

"This guy's dead. We're friends of his."

An instant's pause. Then, in broken English:

"If he is dead, please do not disturb his effects. I am the consul here for a foreign power. I will come within an hour."

He came within the hour, and they gave him all the dead man's effects, including his papers. They never batted an eye. And to this day, the consul does not know that in that intervening hour Government agents had photographed all the papers. These showed that for years the dead man had been collecting and delivering, to a foreign power, interesting information about the local American naval base. In fact, running the tavern was only a side line.

At New York, a few months ago, the great liner *Europa* was sailing. Her pier and decks were crowded; a band played. Up the gangplank walked a plainly dressed man, whose eyes searched for some one. In his hand he carried a violin case. Suddenly, a brawny hand seized it and a sharp voice demanded, "What've you got in this?"

The detective searched, and got a startling answer. The violin case held no violin. It held maps, drawings, papers, about American aviation inventions; a diagram of a flexible machine gun for combat planes. It was these that the man had been about to hand to a ship's steward, to be delivered to agents of a foreign power whose warlike acts are now alarming the world. For that power, the man was a spy in America; the steward, his messenger.

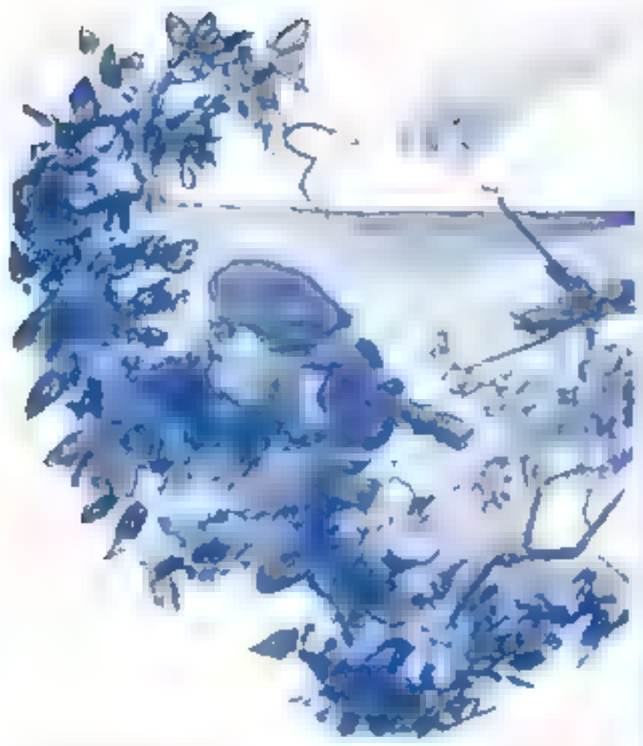
But what could we do about it? Our laws against spying are full of loopholes. Almost any other country would have put the man in prison, perhaps shot him. But, our authorities agreed, about all they could do with him was to get him out of the country. So they threw such a good scare into him that he paid $800 for an airplane to fly him to Canada, and his wife hired the bridal suite on the next big liner. It was the only space that was left, but she just had to get out and spies have money.

Of late, Uncle Sam has cracked down on spies and spying—or tried to, despite the handicaps of weak anti-espionage laws and his own open-hearted nature. But after all, the old gentleman reflects, it's his boys who are inventing these things and perfecting them, not for some grandiose dictator or king, but to protect *him*. And he might as well have the use of the product of his own brains, free from picking and stealing by the scientific spies.

Drawings by
B. G. SEIFERSTAD

In carefully guarded laboratories, skilled chemists are making tests to perfect more deadly war materials. Foreign spies try desperately to steal their secrets

Under the mattress on which a dead man lay, police found a secret telephone. Intercepted messages showed he had been a spy



Long-range cameras, used by spies to photograph ships and forts, have inspired strict Navy Department rules

INTERCEPTING SMUGGLED SECRETS

X-ray cameras like this are used by secret-service men for examining packages that are believed to contain shipments of spy-stolen military inventions

A violin case being carried up the gangplank of a foreign liner was found to contain no violin, but plans and drawings of American military planes

Uncle Sam is paying out $1,000,000,000 this year for an army and navy, but his Army War Plans Division tells him that is only a tenth of what he will spend on equipment alone in one year if he has a war. He will have that war won and be out of it a lot quicker, if he has kept his defense secrets, not left them lying around for his rivals to grab and, perhaps, turn against him.

Uncle Sam has today more and better defense secrets than any other nation in the world. Always a practical fellow, he has realized that if the world just *will* insist on shooting, he had better go to his workshop and fix him up some war machinery of his own. And, having a big workshop and lots of ingenuity, he has turned out quite a collection of war machinery—new cannon and mortars shooting farther than any ever did before, semi-automatic rifles making every doughboy a machine gunner; talking gas masks, seven-man tanks that go over sixty miles an hour; a liquid of chemicals, oils, and T.N.T. to spread devastating fires among enemy munition factories when dropped in bombs or simply sprayed from airplanes.

STEP into a certain sequestered target range. American ordnance experts eagerly surround a new and strange-looking gun. Upon its barrel, balanced just in front of the breach, is an object—why, it's a glass of water! What on earth—

Then the air is stabbed by short, hot reports, incredibly swift and close together. Flame spurts from the gun muzzle. The air quivers, becomes hazy with smoke and gas. But still, balanced triumphantly on the gun barrel, is the glass of water. It has not spilled even a drop!

That feat may prove to have revolutionary effects upon modern war. It demonstrates that once again the impossible seems to have been achieved—a kickless gun. It is a heavy machine gun, firing high-explosive shells with incredible rapidity. It has two amazing new features. It has no kick or recoil, for it utilizes part of the discharge gases to give the barrel a forward thrust as the projectile leaves the muzzle; and after the shot, it does not extract the empty cartridge case until the gases have left the barrel. The new gun can fire 150 high-explosive shells a minute.

Such flocks of shells, exploding at slightest touch, seem to spell destruction for airplanes or tanks. Strictly secret have been the tests of our Army and Navy. But foreign spies have heard of them; foreign governments are making inquiries. No sooner did the Martin and Sikorsky airplane plants start turning out new models of flying boats better than the European models, than agents of five countries were trying to crash the gates for a look at them. Often the traveling representatives of foreign munitions firms are also reserve officers, reporting on the side to their intelligence services.

The scientific spies are after everything they can get, as two recent episodes show. A foreigner, it is said, approached an American Reserve officer who was an expert chemist, often employed on Government work, and offered him $25.000 for the secret formula of the chemical compound with which the Army filled its gas-mask canisters. But the Reserve officer found that formula well guarded. Desperately needing money, he offered $10.000 to a subordinate whom he thought could break down the guard. But the subordinate was more loyal than the Reserve officer; he told his superiors. They took away the Reserve officer's commission, but that was his only punishment.

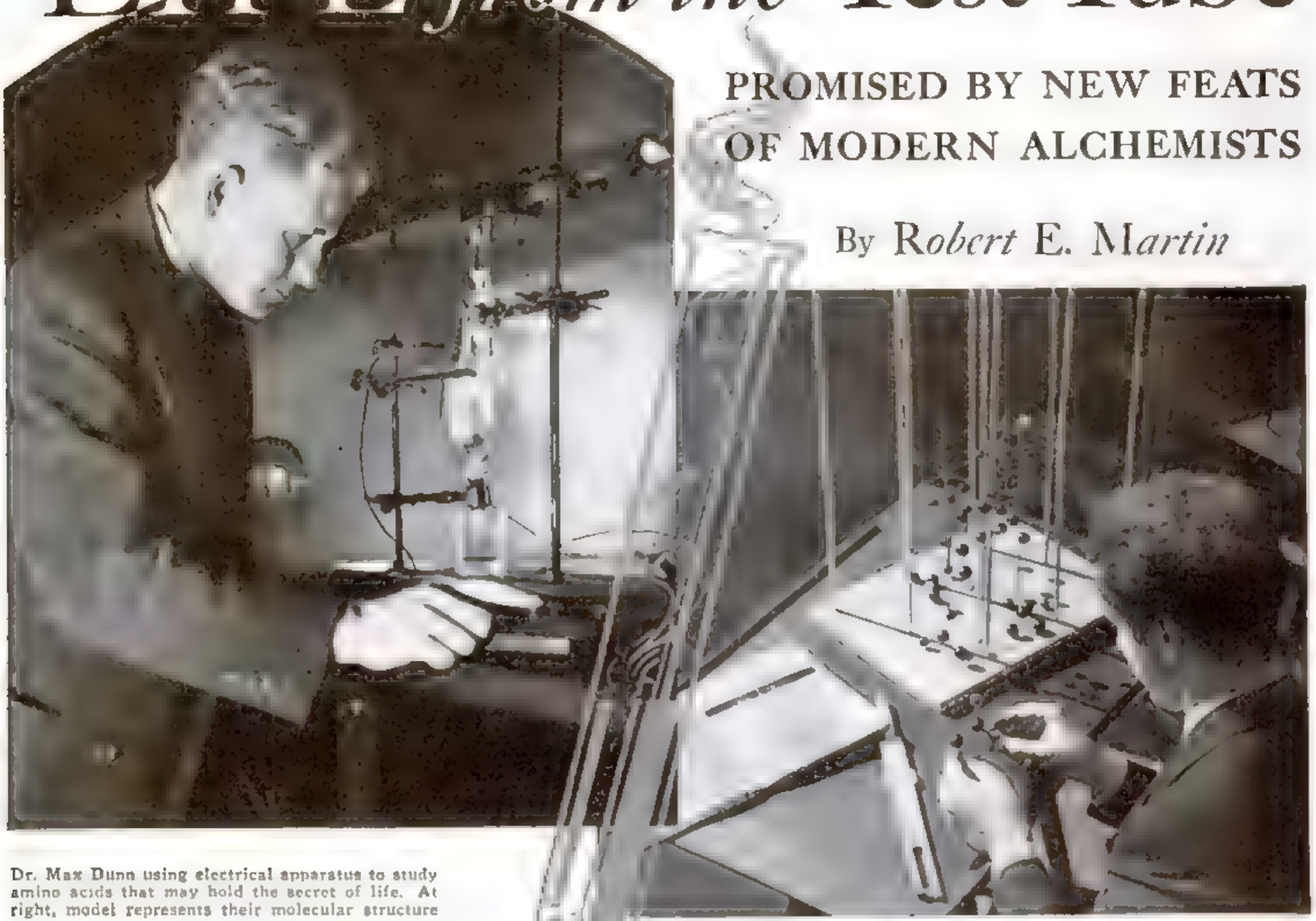
Another American, this time a private citizen but unquestionably loyal, went to Washington to do business with a Government department. He started home again with a brief case filled with plans, blueprints, and drawings closely related to the national defense. On the train, two strangers tried to scrape an acquaintance. They followed him from the station. Later, his office desk was broken open, and his servant was offered $500 to steal the papers. Spies have tried to buy from janitors the waste paper from Government-office baskets. At the Patent Office in Washington, they search patent papers, and often approach American inventors, money in hand. When J. Walter Christie, the famous American tank inventor, resisted their advances, one foreign agent told him: "You might as well sell us your secret; if you don't, we'll steal it."

At last, on *(Continued on page 94)*

LIFE *from the* Test Tube

PROMISED BY NEW FEATS OF MODERN ALCHEMISTS

By *Robert* E. M*artin*



Dr. Max Dunn using electrical apparatus to study amino acids that may hold the secret of life. At right, model represents their molecular structure

FOOD from the test tube, strange acids that conquer disease, complex chemicals that make up the vital ingredients of human flesh and blood—these are recent creations of pioneers in a fascinating, unexplored realm of chemistry, far afield from the normal and conventional affairs of workaday laboratories.

Like seekers of another age, hunting an "elixir of life," these modern alchemists are brewing odorous broths from tons of fish and bales of vegetables in order to extract and study the raw materials of living things. With their new-found knowledge, they are succeeding in putting together extraordinary substances that only nature knew how to produce before. Nearer and nearer they are coming every day to penetrating the age-old mystery of life.

What are you made of? Only now are chemists learning the real answer. Probably you have seen facetious—and unflattering—attempts to evaluate the worth of your body in terms of the market price of its chemical components. You may have been told that you contain just enough iron to make one medium-size nail; enough calcium, or lime, to whitewash a chicken coop; and sufficient sulphur to rid one dog of fleas! Little more impressive, in such an estimate, is the commercial value suggested for the carbon, hydrogen, oxygen, and nitrogen in your body. But let your detractor take just those last four chemicals and try to rebuild them into the staggering complex compounds of which human tissue is made. It may salve your wounded vanity to learn that the nearest laboratory approaches to duplicating these mysterious ingredients of the human body are yielding chemicals that sell for as much as a thousand dollars a pound!

Headquarters for the manufacture of these almost priceless substances is a group of underground, cell-like laboratories at Los Angeles, Calif., where a visitor sees crack research workers under Dr. Max Dunn of the University of California handling rare crystals as if they were crown jewels. Thermostats click occasionally as a liquid-filled vessel cools with infinite slowness—less than a tenth of a degree a day. Crystalline forms in this liquor, gradually taking shape from tiny "seeds," will permit the first detailed examination of a substance that never before has been obtained in the pure state.

One of the white-smocked experimenters, as you pass through this inner sanctum of chemical magic, is mounting such a crystal in a curious brass instrument called an optical goniometer, so that he may peer through a telescope-shaped eyepiece and measure the angles of its gemlike facets. Another worker, in a lead-lined cell, is placing a glass tube filled with powdered crystals in a powerful X-ray gun. As high-tension electricity buzzes through the vacuum tube, a shadow picture revealing the innermost structure of the mysterious chemical is imprinted upon a photographic film. At a near-by workbench, a giant model of a molecule is slowly taking form, as an assistant fits together black and red balls with wooden rods. It is a representation, billions of times enlarged, of a molecule of the substance under examination, and new groups of balls, representing atoms, are added to fit each new specification disclosed by the delicate laboratory tests.

Just one short step removed from life itself are the precious substances that the Los Angeles experimenters are producing. What flour is to bread, they are to the proteins of the human body—and that is almost as much as saying, the human body itself. They are amino acids, the building blocks of which proteins are made. And it is proteins themselves that constitute the principal material of skin, hair, blood, and muscle—in short, the stuff that human beings are made of. The cells of which your body is composed, one million billion or so of them, are blobs of jellylike protoplasm consisting mainly of protein.

SO APALLINGLY complicated is the chemical structure of a protein that no chemist to date has succeeded in creating a single one. But scientific pioneers, by taking them apart to see what they are made of, have already blazed a trail for the bold leader who may step forward tomorrow and put a protein together in a test tube.

Strange things, seemingly more in keeping with a sorcerer's den than a modern laboratory, went into the retorts of these research workers—squash seeds and fish entrails, hen's eggs and wheat, horsehair and goose feathers. With boiling acid, experimenters gave them a chemical "third degree" to try to break them down into simpler substances. What they obtained were near-proteins that they named amino acids—the queer name signifying, to a chemist, the distinctive character of the nitrogen compounds they contain. Were these newly isolated substances the long-sought chemical "missing link" between the realms of inert and living matter?

This instrument, an optical goniometer, measures the angles of facets of crystals grown in the laboratory

Pure amino acid crystals grown from tiny "seeds"

FURTHER tests showed that they were. A molecule of protein such as is found in living matter, X-ray analysis indicated, is a complicated network or chain of these amino-acid molecules. By linking different kinds of amino acids together in various patterns, millions of kinds of proteins are theoretically possible—far more, in fact, than all the known species of plants and animals on the globe and therefore plenty to account for nature's infinite variety.

So vital to life are these "missing-link" chemicals known as amino acids that all animals, man included, would quickly perish if deprived of a constant supply. Yet plants alone, in nature, possess the power of manufacturing them from simple materials. Drawing up nitrates from the soil, the plants combine nitrogen from these compounds with carbon dioxide and water to form amino acids, which in turn are built into the different plant proteins.

Animals, unable to duplicate this feat, must feed either on plants or upon other animals that are vegetarians to obtain the amino acids that are essential to their existence. When you eat proteins of plant or animal origin, the digestive fluids break them down at once into their constituent amino acids. The blood stream distributes these to the tissues of the body, where they are rebuilt into the characteristic animal proteins of the particular tissues. Thus they help build up new cells to replace the ones that are constantly broken down by the wear and tear of life processes. Another vital role is played by these mysterious acids in the production of the hormones, or chemical messengers, that speed through the body to regulate growth, fat-building, and other functions. One thousandth of an ounce of an amino acid called thyroxin, concentrated in the thyroid gland, separates every normal human being from imbecility or death.

No wonder, then, that chemists have eagerly set out to discover the true nature of these all-important chemicals. To date, some twenty-two different amino acids have been found and named. Chemists have learned to draw complex formulas for them, as an engineer draws plans for a bridge. Many—including thyroxin—have actually been created in the laboratory. Others are being isolated and purified from natural proteins, like white of egg, gelatin, and casein. Dr. Dunn's laboratory is a miniature factory, producing them as needed by other research laboratories where their remarkable properties are being disclosed.

One of the "missing-link" chemicals, named cystine, has been found to have a startling effect on the growth of hair. Sheep, fed with it, produce abundant wool of superior quality.

A compound of another, called d-glutamic acid, flavors food with a meatlike taste. Millions of dollars' worth of this acid is sold each year to people in the Orient who like meat but are forbidden by their religion to eat it.

Daily administrations of a few grams of a third, named glycine, have been found to aid in curing myasthenia gravis, a strange malady producing muscular weakness.

Most spectacular, however, of the by-products of the search for the chemical secret of life is the production of synthetic food.

Scientists have dreamed of producing artificial "food pills" that would contain everything necessary for life—a feat that would render man forever independent of natural resources for his nourishment, and banish fear of crop failure and famine. Now, as every one knows, human food consists of

(Continued on page 118)

X RAYS HUNT THE SECRET OF LIFE

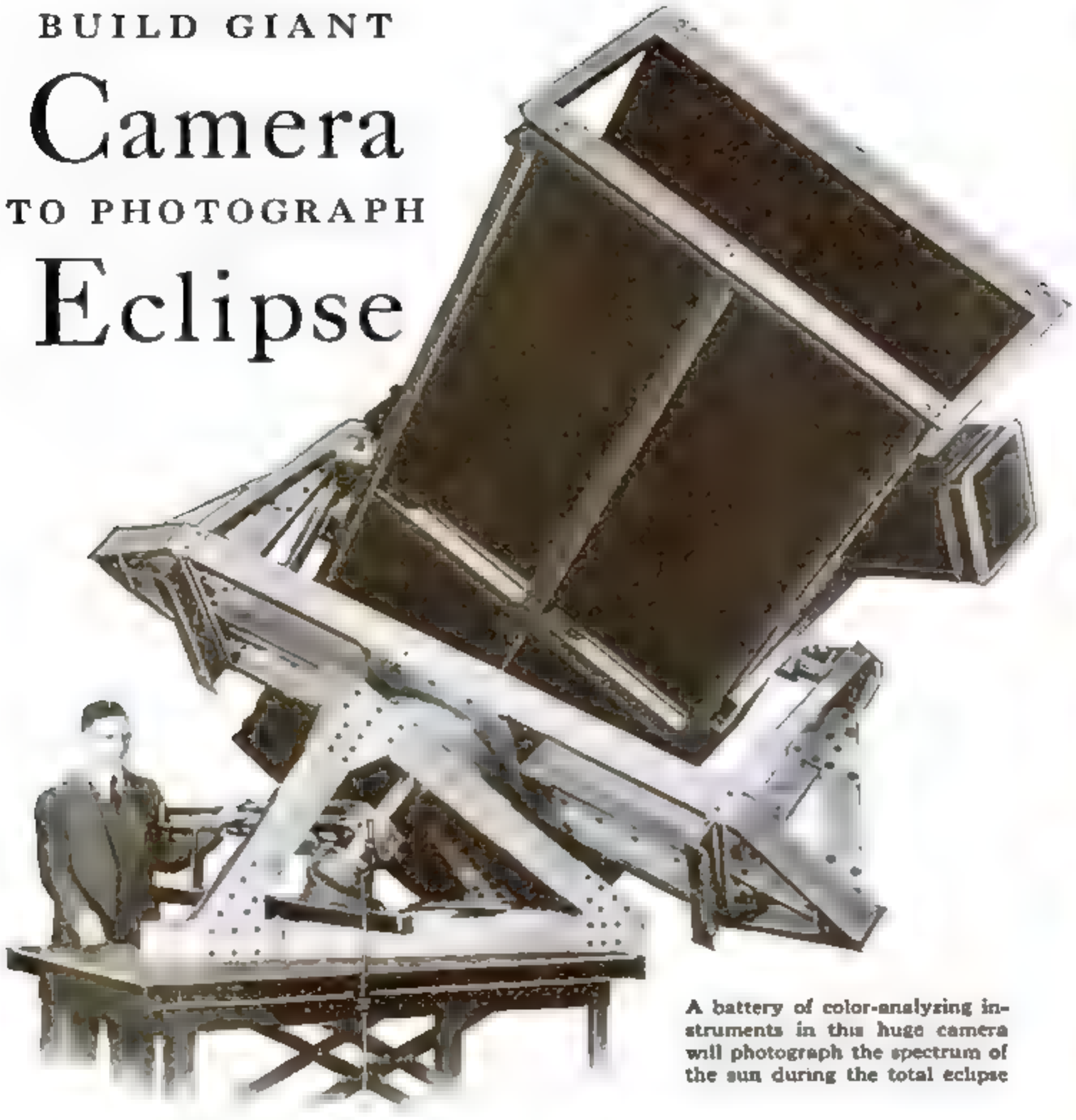
Above, a tube of powdered crystals, held in tweezers, is being placed in a film magazine for X-ray analysis. Crystals diffract rays into telltale patterns for recording on film. At the left is seen the powerful X-ray gun with several magazines around its central tube chamber

BUILD GIANT

Camera

TO PHOTOGRAPH

Eclipse



A battery of color-analyzing instruments in this huge camera will photograph the spectrum of the sun during the total eclipse

AMERICAN astronomers, journeying halfway around the world to view the total solar eclipse of June 19, will train giant cameras of new design upon the sun to find out more about what it is made of. The lightweight alloy case of one of the instruments, illustrated above, measures fifteen feet in height and houses a battery of spectrographs, or color-analyzing cameras. They decompose sunlight into a rainbowlike band of hues called a spectrum, and their shutters will click once a second to record every tint in the light emitted by the sun during the eclipse. Another huge photographic instrument will make motion pictures of the sun's spectrum on a film thirty inches wide. The cameras will be placed in action near Ak-Bulak, near the southern end of the Ural Mountains in Siberia, by a joint expedition of Harvard University and the Massachusetts Institute of Technology.

NEW AUTO-OILING SYSTEM GIVES MORE MILEAGE

BY LESSENING friction in automobile bearings and pistons, a system of motor lubrication devised by a Larchmont, N. Y., inventor is said to have given unusually high fuel economy in test runs. Conventional systems lead oil up a hole bored in the connecting rod to the wrist-pin bearing, through which it gradually escapes to the cylinder walls. The new method provides a special oil pipe for the connecting rod, and an overflow hole through which oil at the wrist-pin bearing squirts against the piston and floods the cylinder wall.

The inventor with a connecting rod used in a new auto-lubricating system. Note the oil pipe

KNIFE CARVES FIBER BOARD

DECORATIVE designs are easy to cut in fiber board with a convenient hand tool recently introduced. Its rounded handle provides a firm grip upon a razor-sharp, heavy-duty knife blade, as shown in the photograph above. Spare blades are carried in the hollow handle, which is opened by the removal of a screw.

PLANTER VARIES DEPTH OF SEED

BY PLANTING seeds at varying depths instead of covering them with a soil layer of uniform thickness, an implement devised by government agricultural experts assures cotton growers of a satisfactory stand of plants regardless of varying weather conditions. An undulating furrow opener, moved by an ingenious cam arrangement, replaces the standard fixed furrow opener in the new machine. As the machine is propelled along the ground, the resulting rocking action of the furrow plow gives a wavelike profile to the bed upon which the seeds are dropped, as shown in the accompanying diagram. When the furrow-closing wheel has leveled off the surface of the soil, some of the seeds lie barely covered, while others are at depths up to one and a half inches. Since the action is entirely automatic, no special skill or practice is required on the part of the operator.

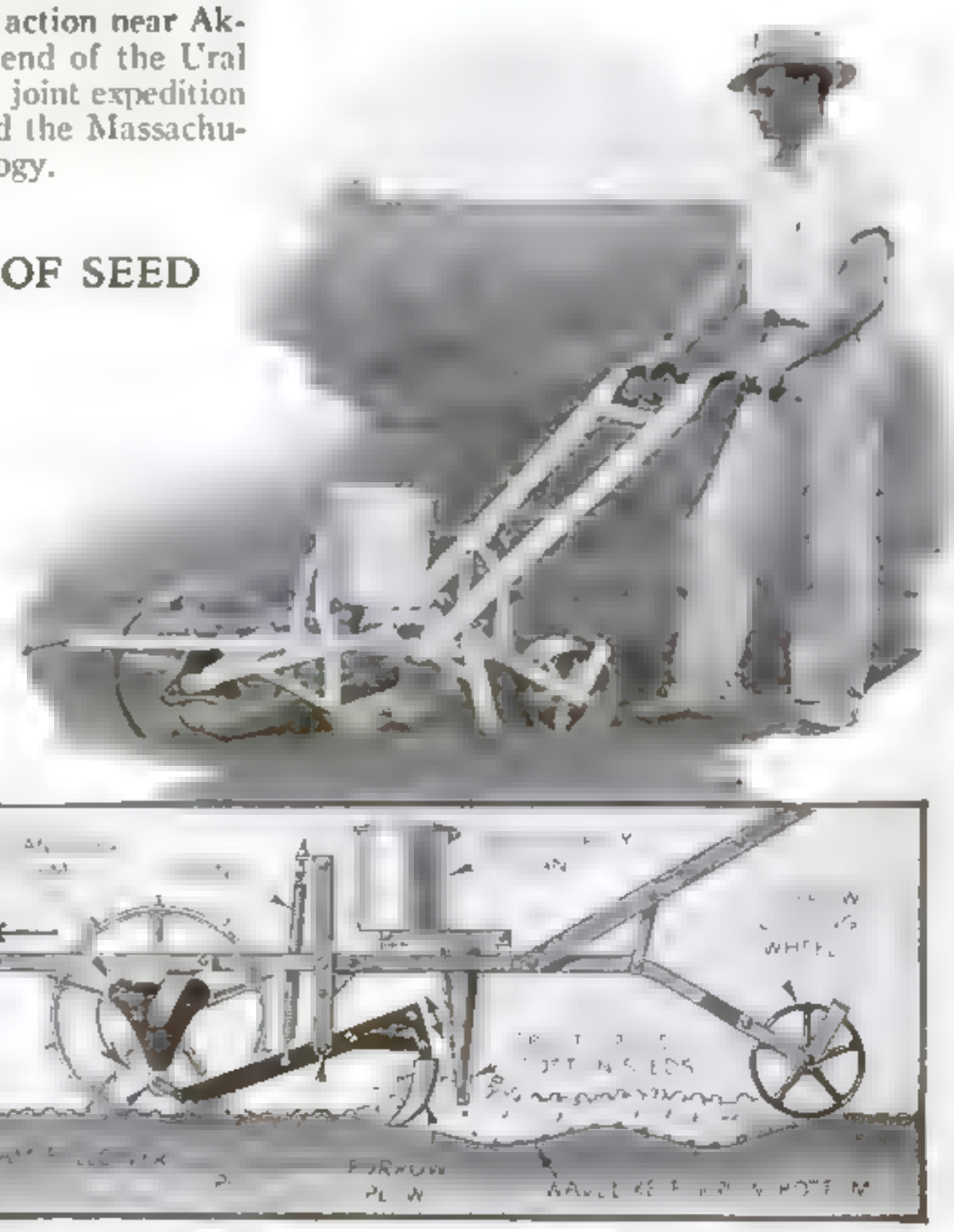


Diagram shows how a cam produces an undulating motion in the furrow plow to make a wavelike furrow. Above, the new cotton planter in use

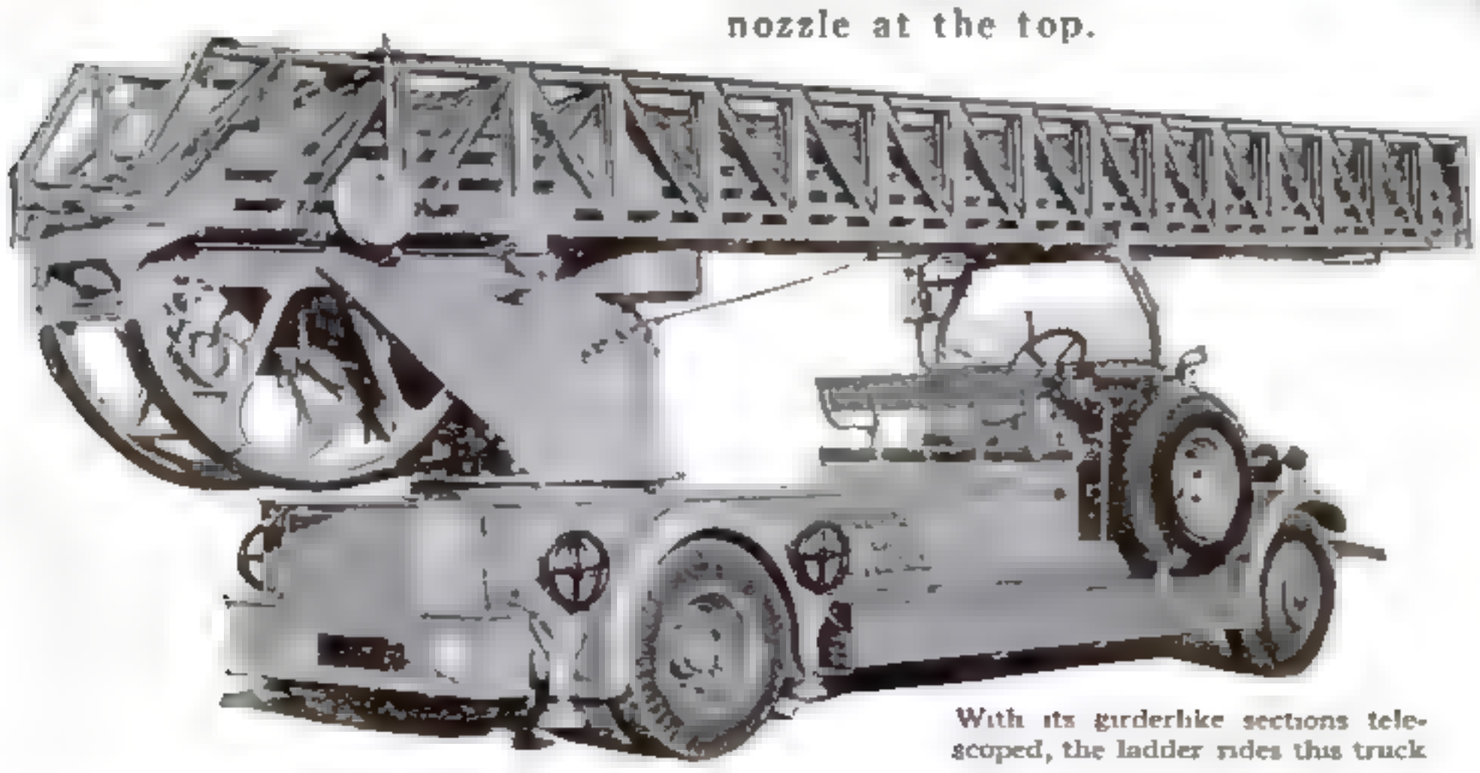
NEW AIRPLANE CARRIERS TO BE SMALLER AND FASTER

"POCKET" aircraft carriers of 3,000 tons displacement are proposed by a leading British armament firm to replace larger types, which are declared costlier, slower, and more vulnerable to enemy bombing planes. One of its designs, illustrated above, uses amphibian planes and provides a stern ramp for their return. A modified design, for seaplanes, substitutes catapults for a flying deck, and picks up aircraft on a trailing canvas apron while traveling at its full speed of twenty-eight knots.

FIRE LADDER EXTENDS TO 164 FEET

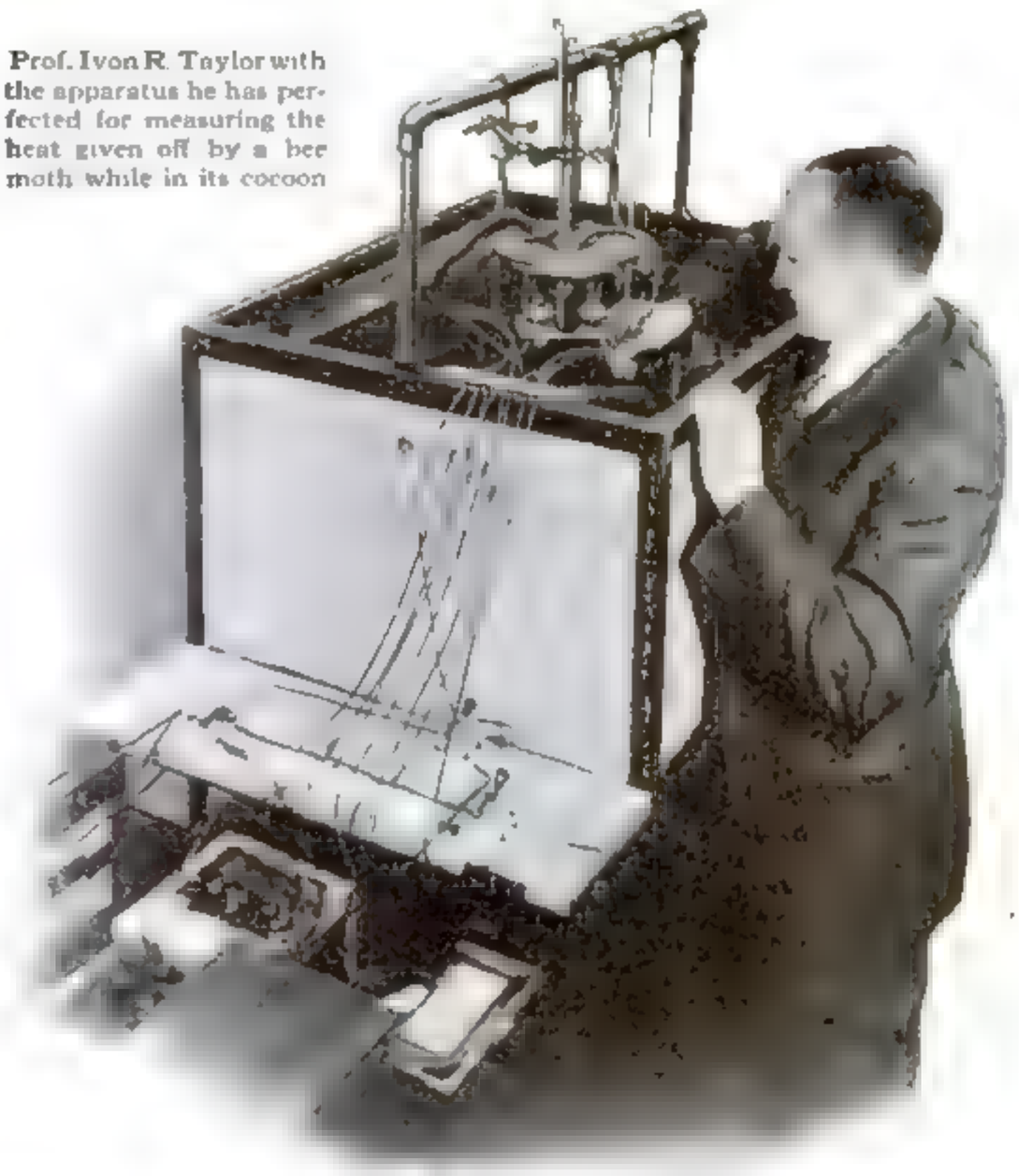
STRETCHING 164 feet into the air, one of the tallest extension ladders ever constructed has just been placed in fire-fighting service in Buenos Aires, Argentina. Consisting of five telescoping girderlike sections, the giant apparatus is mounted on rocker arms at the back of a heavy-duty fire truck. Four jacks, built into the truck chassis and fitted with ground-gripping shoes, are screwed down to the road surface to provide a firm foundation before the ladder is raised. With its aid, persons may be rescued from the tallest buildings, and water may be directed at the flames from a nozzle at the top.

Fire ladder extended to its full length. Four jacks screwed to the ground steady it



With its girderlike sections telescoped, the ladder rides this truck

Prof. Ivon R. Taylor with the apparatus he has perfected for measuring the heat given off by a bee moth while in its cocoon



ODD INSTRUMENT GAUGES HEAT FROM MOTH COCOON

WHAT mysterious processes transform a crawling grub into a beautiful butterfly or moth? To find out, a scientist is employing ingenious instruments to study a species of moth during its pupa or transition stage, which ends when it emerges from its cocoon. So sensitive is one of his instruments that it measures the heat given off by a pupa, the organism within a cocoon. One of these "moths in the making," he has found, emits enough heat in one week's time to raise a quarter thimbleful of water from freezing to boiling temperature.

STUDY EROSION WITH SCALE MODEL OF COLUMBIA RIVER

A portion of the Columbia River as reproduced in a complex working model at the University of California. At left, a thistle tube containing dye which spreads in water to show the effect of tides on the river's flow

Bits of confetti swirling in the miniature stream to visualize the many currents. The locality represented is a bay in the lower river

BY reproducing the lower 140 miles of the Columbia River and adjacent sections of Oregon and Washington in a tiny model on the University of California campus, engineers hope to find means of permanently controlling erosion and deposit of silt and sand in the estuary of that great arm of the Pacific Ocean.

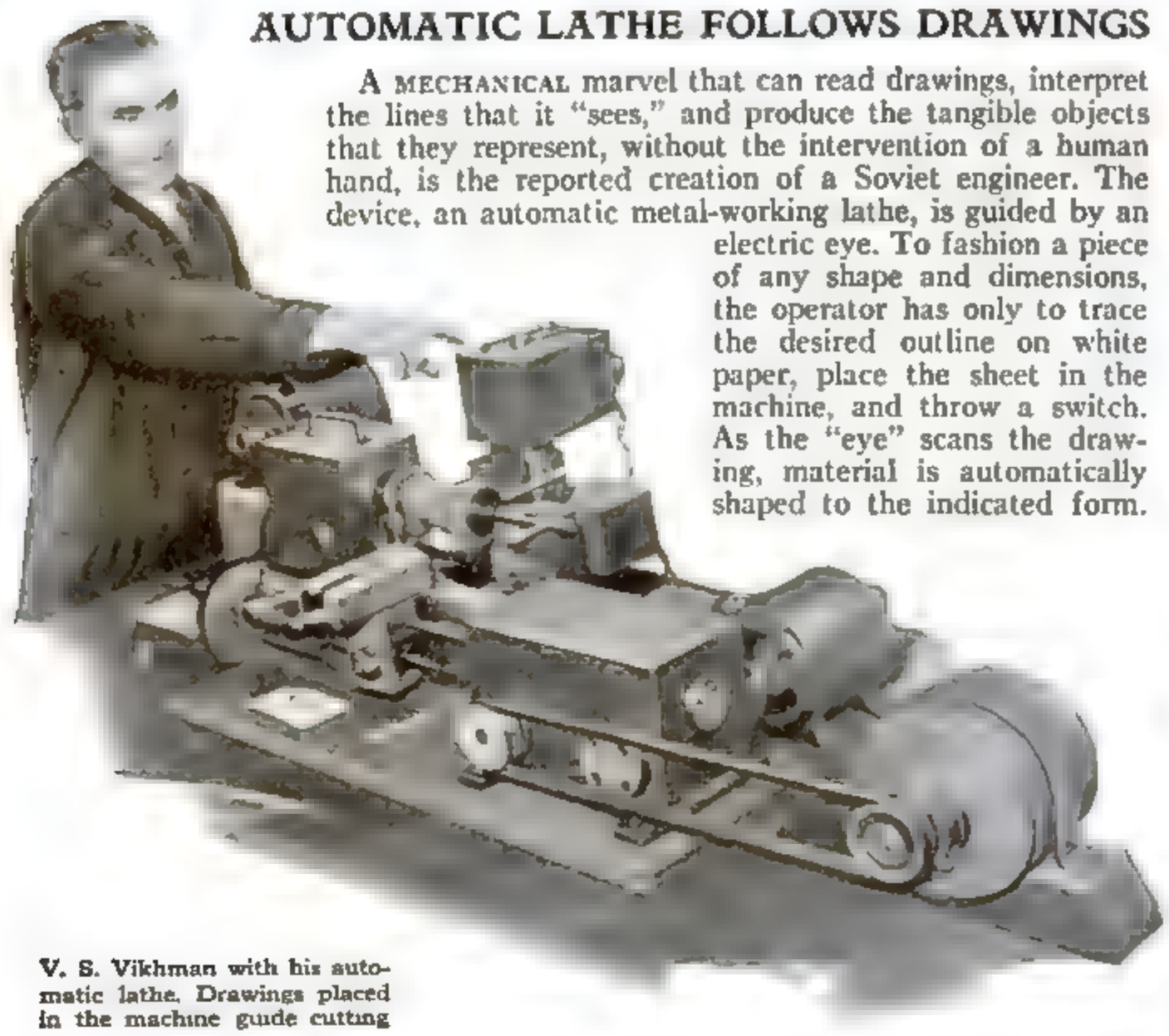
Although only two feet deep, water in the model behaves exactly like that in the Columbia. The miniature stream may be made to flow at any level and speed, while tide and wave machines force the river to "back up" so that studies may be made not only of the tidal action but also of tiny waves as they lap at a miniature beach.

Confetti, placed in the water, is photographed as it follows the currents in their wanderings; a red dye is used to indicate the course of the tides, while small current meters register how rapidly the water backs up and flows again toward the sea.

For more than a generation, means have been sought to straighten, deepen, and maintain the Columbia channel, and before spending additional millions in construction of dikes, jetties and weirs, proposed construction will be tested out on a small scale with the model.

AUTOMATIC LATHE FOLLOWS DRAWINGS

A MECHANICAL marvel that can read drawings, interpret the lines that it "sees," and produce the tangible objects that they represent, without the intervention of a human hand, is the reported creation of a Soviet engineer. The device, an automatic metal-working lathe, is guided by an electric eye. To fashion a piece of any shape and dimensions, the operator has only to trace the desired outline on white paper, place the sheet in the machine, and throw a switch. As the "eye" scans the drawing, material is automatically shaped to the indicated form.



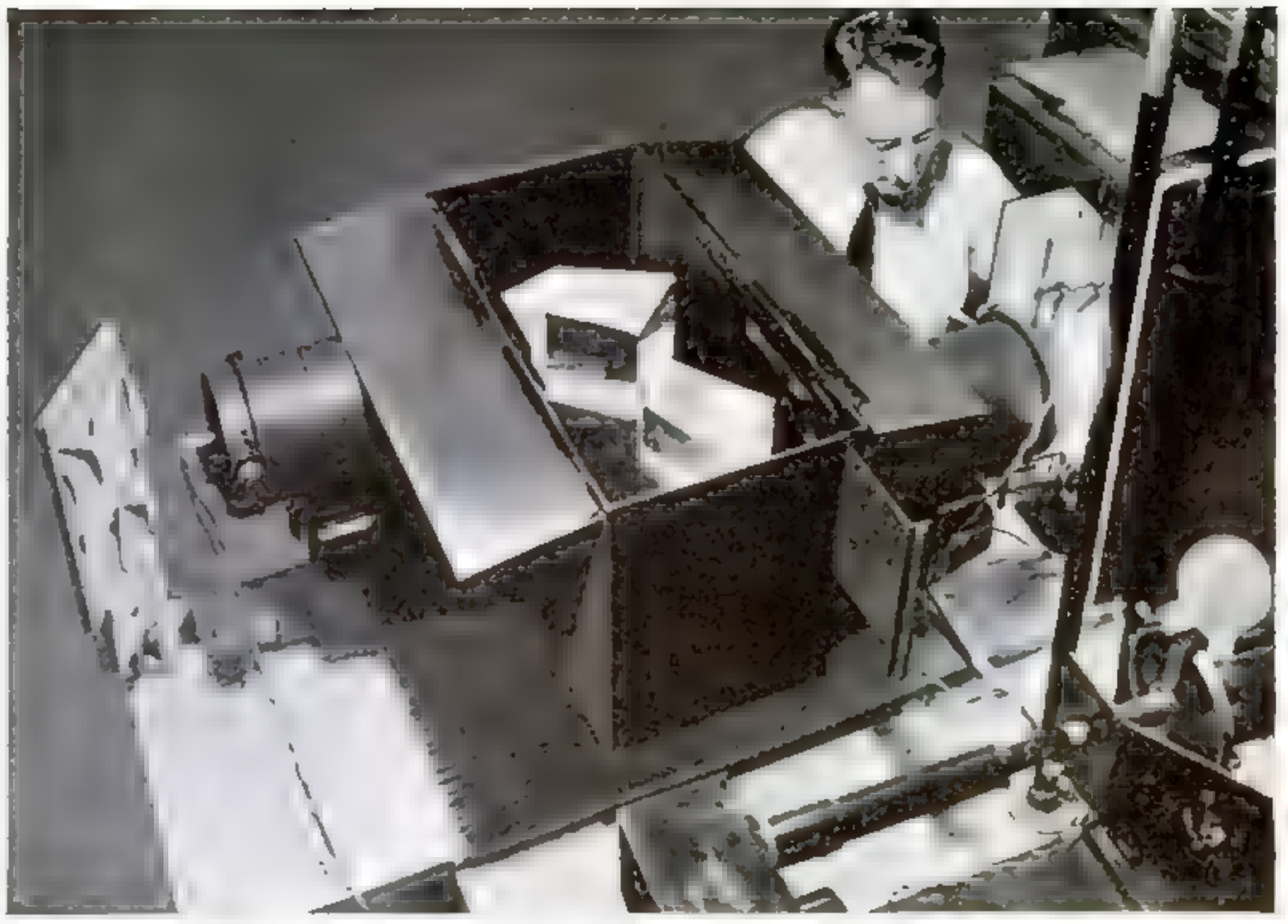
V. S. Vikhman with his automatic lathe. Drawings placed in the machine guide cutting

NONSTICK ICE-CREAM DIPPER HAS DEFROSTER IN HANDLE

A "SELF-DEFROSTING" dipper has been devised for serving individual portions from a can of ice cream. Made from one piece of polished metal, the implement has an egg-shaped scoop at one end; when drawn across the surface, it curls up a wide ribbon of ice cream into a loosely packed ball. A fluid sealed in the handle has a defrosting effect which prevents the ice cream from sticking; thus no ejector, lever, or spring device is necessary to release the portion into a dish or cone.

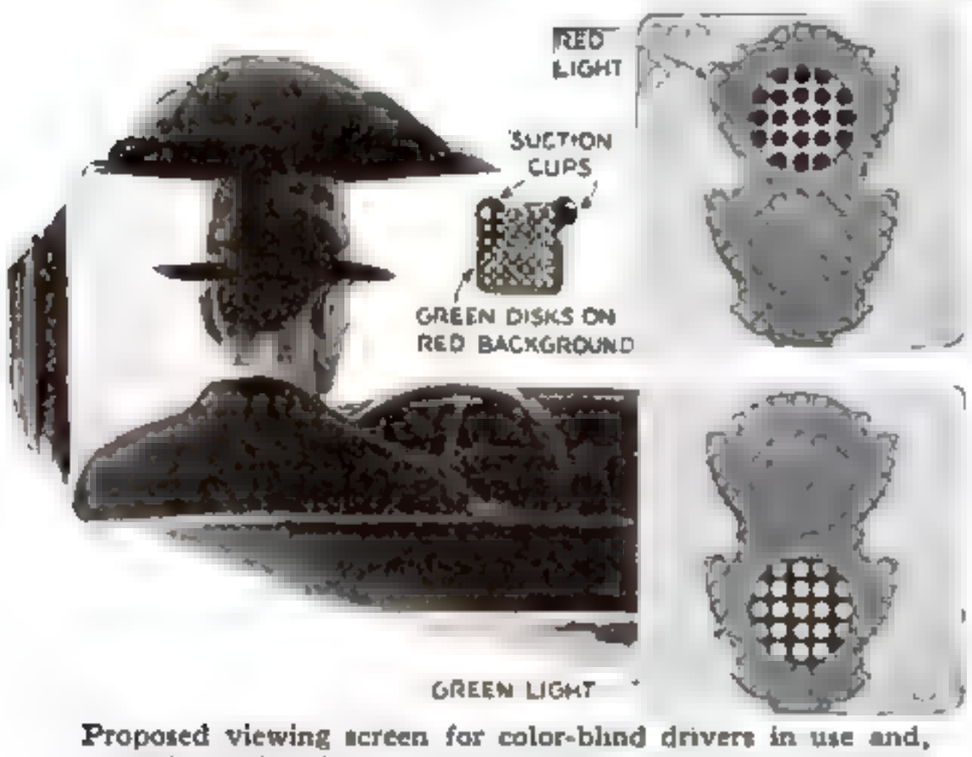
FILTERED LIGHT RAYS COMBAT BONE DISEASE

WHAT is called the world's most powerful source of single-colored light has just been placed in service by General Electric Company engineers as a new research weapon in the war against disease. When light from a mercury-vapor arc lamp passes through the instrument, only ultra-violet rays of a selected wave length emerge. By anesthetizing rats that are suffering from the bone disease of rickets, and exposing them to measured, curative doses of this pure, unmixed light, investigators are assembling data that may help guard children from the same dread malady. The filtered light is also being tested for sterilizing food and liquids. A two-hour exposure with the new apparatus corresponds to one of several days with ordinary equipment of the type. The instrument is technically known as a monochromator, and employs two giant prisms of fused quartz, weighing seven and ten pounds respectively, to strain out unwanted light rays.



A rat, anesthetized and stretched on the board at the left, being treated for rickets with ultra-violet light. Two giant prisms of fused quartz, seen in the black chamber, filter out all unwanted color rays

SCREEN AIDS COLOR-BLIND DRIVERS



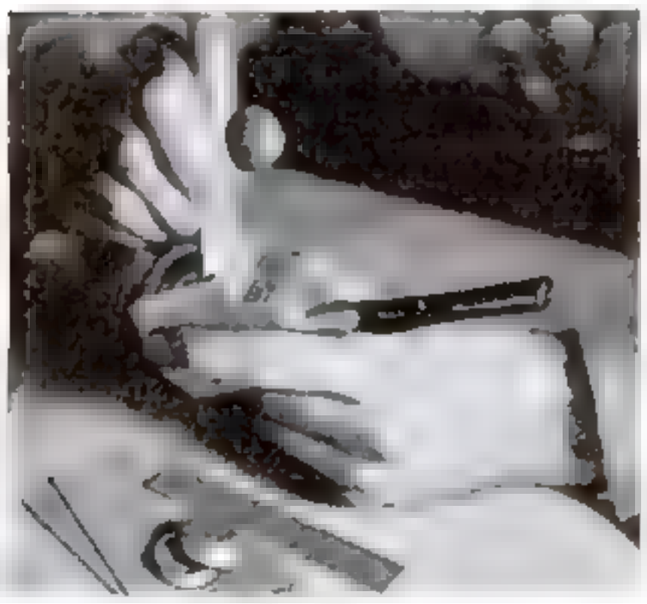
Proposed viewing screen for color-blind drivers in use and, at right, polka-dot patterns it gives red and green lights

COLOR-BLIND motorists, ordinarily unable to tell a red traffic light from a green one, could drive in safety behind a windshield attachment proposed by Thomas Ross, of the University of Washington. Viewed through a screen made by punching holes in a sheet of red transparent material and inserting disks of green transparent material, the lights would take on polka-dot patterns. A green light would appear dark with bright spots, and a red light, bright with dark spots, permitting the two to be readily distinguished.

Door knocker made to look like woodpecker

KNOCKER RESEMBLES A BIRD

WHEN a projecting knob of a novelty door knocker devised by a California inventor is twirled, a carved likeness of a woodpecker rains a succession of blows upon the door with its metal "bill," and a realistic rat-tat-tat is heard within. The decorative, brightly painted fixture is suggested by its designer as especially appropriate for woodland cabins and other houses of rustic design.



SMOKERS CARVE PIPES WITH NOVEL KIT

A SMOKER may shape a pipe to suit his personal taste, with a carving kit now on the market. The outfit provides a block of brier wood, roughly squared up, with a standard hard-rubber mouthpiece already fitted; a special carving knife; and an oilstone, sandpaper, and pipe wax.

RADIO ANNOUNCER TALKS THROUGH HIS HAT

RADIO engineers recently demonstrated their versatility by building a broadcasting station into a hat. The miniature set, complete in every detail, enabled an announcer strolling along one of New York City's principal thoroughfares to offer first-hand comment upon spring fashions in apparel encountered along the way. The wearer of the portable transmitter, and his companions, spoke by turns into a small microphone which was connected to the set by a flexible cord. Batteries hanging inconspicuously from a belt provided the necessary electric power, and the only oddity about his costume visible to observant passers-by was a small antenna rod protruding from the announcer's silk topper A central studio picked up the short-wave broadcast and retransmitted it to radio listeners.

Radio transmitter in a top hat, and belt with batteries

Irá'oor Blizzards...

A SYNTHETIC SNOWSTORM. Twenty-five-pound cakes of ice, fed into this snow machine, are chopped into fine flakes which are sprayed over winter settings

THE ARCTIC IN HOLLYWOOD

A real Eskimo igloo, made of blocks of ice and covered with machine-made snow

PRODUCED IN REFRIGERATED MOVIE STAGE

ICY WINDS beat against the walls of a backwoods cabin, carrying snowflakes that swirl past the windows and pile up in drifts around the stoop. In front of the door, a snow-encrusted bridge spans a narrow expanse of glistening ice. Men and women, bundled up in heavy winter clothing, lean against the force of the gale as they move about, breathing puffs of fog into the wintry air.

When you witness the scene on the screen of your movie theater, it will have an air of grim reality. And, as far as physical conditions go, this is a genuine blizzard that is being photographed. Wind, snow, and ice —even the icicles that fringe the eaves of the house— are real. The cameramen and technicians behind the battery of lights stamp booted feet and wave their arms to keep warm. Yet, only a few feet away, beyond the insulated walls of the stage where the picture is being made, the Southern California sun is shining with all its summer heat.

The refrigerated stage is Hollywood's latest aid in bringing realism to motion pictures. Instead of spending vast sums of money to send players and technicians "on location" to the snow fields of the High Sierras, or even as far away as Alaska, producers now can film their winter sequences right in Los Angeles, only a short distance from their home studios.

The first of these ice-box stages utilizes the interior of an ice-storage plant, which was stripped of its load of 10,000 tons of manufactured ice and studded with studio lights and painted sets. Snow slingers and wind machines were installed, making it possible to create at the wave of a hand any of the scenes common to lands of boisterous winters.

The building is 140 feet long, 100 feet wide, and forty feet high, with walls and roof completely insulated by a fourteen-inch layer of granulated cork. Three miles of coiled pipes lie in triple banks three deep suspended from the ceiling, forming an ammonia-

A winter scene being photographed in the refrigerated stage. The walls and roof of the building are insulated with cork. The pipes of the refrigerating system are seen suspended from the high ceiling

By MEL WHARTON

refrigeration system that can reduce the temperature of this vast room to ten degrees above zero, Fahrenheit, and hold it there indefinitely.

A portable snow machine makes actual snow out of twenty-five-pound cakes of ice that are tossed into a hopper in which spiked cylinders crush the blocks and chop them into flaky white chips. The snow is hurled through a centrifugal slinger sixty feet out over the sets, where it drifts naturally upon roofs, fences, and ground and clings realistically to trees and shrubs. Impelled by gusts from a wind machine, this man-made snow is said to be indistinguishable from the outdoor variety. The machine eats 300 pounds of ice for each minute of snow.

The cabin of a Canadian trapper can be reproduced now in Hollywood in midsummer. The icicles that hang coldly from its eaves are chill and brittle. They have been made and frozen in a water mold, and "pasted" on the set wherever needed by means of a little water that quickly freezes them solidly in place.

Before the advent of the refrigerated stage, a chemical known as "hypo ice" was used wherever the appearance of an ice sheet was needed on an indoor set, and white gypsum fluttered down out of a dull sky as a crude imitation of snow. But the effect was often destroyed by the unlifelike setting. "Fog-breath"—one of the touches of realism never before possible with indoor winter scenes—comes as a natural consequence of the below-freezing temperatures always maintained in the ice-box stage.

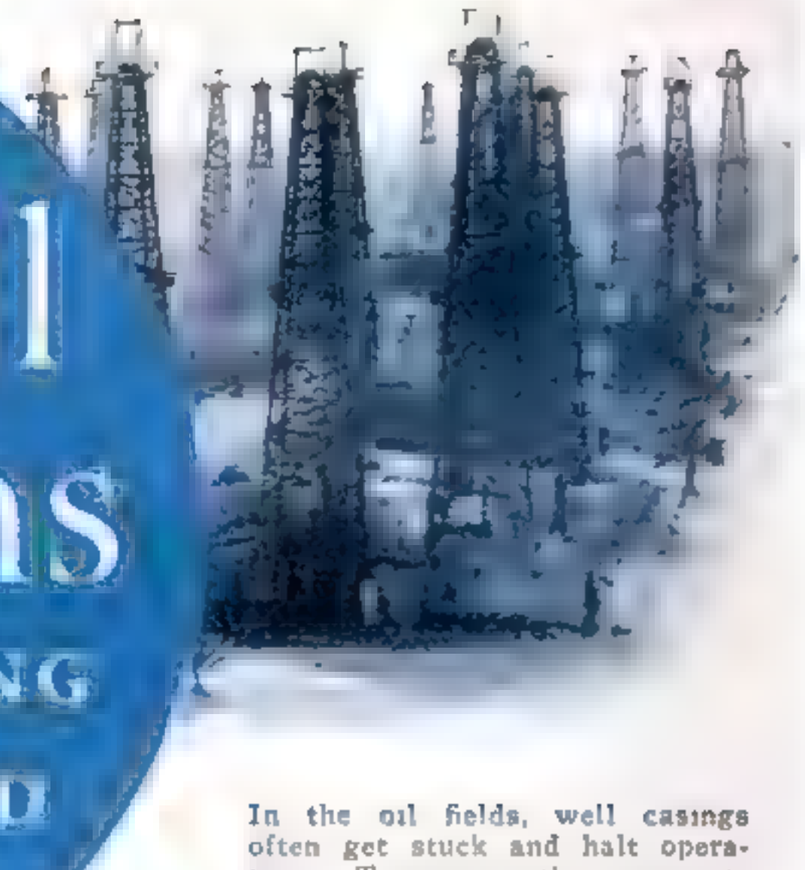
Even the Eskimo's igloo is faithfully reproduced with blocks of ice, laid like stones in a wall and then covered with a blast of snow from the snow-throwing machine. The frozen surface of a lake or stream is almost instantly made by flooding water upon the required spot. The ice withstands skate runners on its flinty surface.

The idea of bringing winter to Hollywood was inspired by the recent near-disastrous experiences of two Hollywood motion-picture troupes that became snowbound near Truckee, in California's High Sierras. Influenza broke out, medical assistance could not be obtained, and the companies were delayed for more than twice the estimated time of their visit.

The cost of keeping an actor or technician a day on location is estimated at twenty dollars, not including salaries. An expedition of fifty out on "arctic" location either in Alaska or the Sierras means approximately $7,000 a week. The refrigerated stage may divide this figure by ten.

JACK FROST'S UNDERSTUDY. This studio worker has the queer job of freezing molded icicles onto the eaves of a house

Oil-Well Surgeons PERFORM AMAZING UNDERGROUND OPERATIONS



In the oil fields, well casings often get stuck and halt operations. To loosen them experts use giant 100-ton jacks similar to that shown at the extreme left

Probing Far Beneath The Earth With Fantastic Tools, "Fishing" Crews Remove Obstacles That Halt Drilling

By STERLING GLEASON

WHEN an oil well gets a bone stuck in its throat, it's time to call a doctor. Not long ago, a telephone message sent a California oil-well surgeon hurrying to a drilling well that was "choking." Three thousand feet below the ground, the drill pipe was stuck, wedged firmly by a caving formation which had slipped into the hole.

Cautiously the expert applied the power of the steam-driven draw works to the drill. Steel cables sang under the terrific pull, the derrick shivered under the strain of hundreds of horsepower, but the jammed pipe refused to budge.

Huge jacks, capable of lifting 150 tons each, now were brought into play; they, too, failed to stir the tightly stuck pipe. Finally, the surgeon selected a set of "jars" from his kit of instruments. This tool is a giant slip joint which offers no resistance to an upward pull until it is extended several feet; then it jerks up tight, giving a sudden yank to the pipe.

Tapping upward with gradually stronger blows, the tool hammered again and again, until hundred-ton raps finally loosened the pipe and it was drawn up easily.

A thousand dollars a day—that's what a second's carelessness may cost in the oil fields. The failure of a cable, the breaking of a tool, or any of a host of accidents may suddenly threaten to ruin a well that has cost hundreds of thousands of dollars to drill. In spite of all precautions, such accidents do happen, and that is why skilled "fishing" crews get fat fees for their first-aid emergency operations on ailing wells.

These surgeons of the oil fields, with their highly developed technique and their weird arsenal of specially contrived tools, know how to probe thousands of feet beneath the earth's surface and perform amazing feats of underground surgery. Every operation is a gamble in which not only the life of the "patient," but the reputation of the expert as well, hangs in the balance. Few men are trained in this difficult technique, and money is no object when their skill is needed.

Not long ago, drillers were driving a well down through a formation so hard that even a bit edged with diamondlike alloy steel made slow progress and had to be sharpened often. While they were changing drills, an eight-pound sledge hammer slipped unnoticed into the hole.

When the new bit was screwed on, drilling seemed to have struck a snag. Hour after hour the drill pipe rotated, but no progress was made. Occasionally it gave a sudden jerk which called for the driller's closest attention to keep the pipe from slipping.

Suddenly, the driving engine raced frantically, and the steady beat of the pumps

Lost cables are fished up on the barbs of this harpoonlike spear. The drawing below shows how "fishing" crews handle this and other mishaps of oil-well drilling

changed to a frantic clanking. On the dials of the driller's gauges the needles fluctuated wildly, automatically diagnosing the trouble. The drill pipe had parted. Up came the pipe from the hole, section by section, until more than a mile of it was stacked beside the derrick. The last piece ended in a broken stump, indicating to the experienced drill crew that the drill collar holding the bit had failed.

Down went the pipe again, with a hooklike tool attached to its end. When it was brought up, it had the lost collar and bit speared on its barbs. Examining the removed bit, the driller saw that one of the toothed cones which rotate on pivots, milling into the rock like tiny saws, was missing. For days, the crew sought with every instrument at their command to remove the lost cone. Meanwhile costs piled up rapidly—rentals on machinery, wages of the crews, fuel and water bills. It is a maxim of the oil fields that a "fishing" job or two may break a sound company.

The driller hated to give up, for he knew a fishing expert's fee would be high, but at length he summoned a specialist. This expert listened to the tale of woe and decided to see for himself just what was happening below ground. To the drill pipe he attached an impression block, a tool faced at its lower end with a thick block of soft lead. His men lowered it to the bottom, allowed the weight of the drill rod to rest on it a moment, then carefully backed it out of the hole.

WHEN the last "stand" of pipe was stacked away, the experts eagerly examined the impression block. Stuck firmly in the soft metal was the lost cone! But another impression, stamped intaglio-clear into the face of the block, met their eyes. Plainly it was the mark of a sledge hammer, wedged into the hard formation at the bottom of the well.

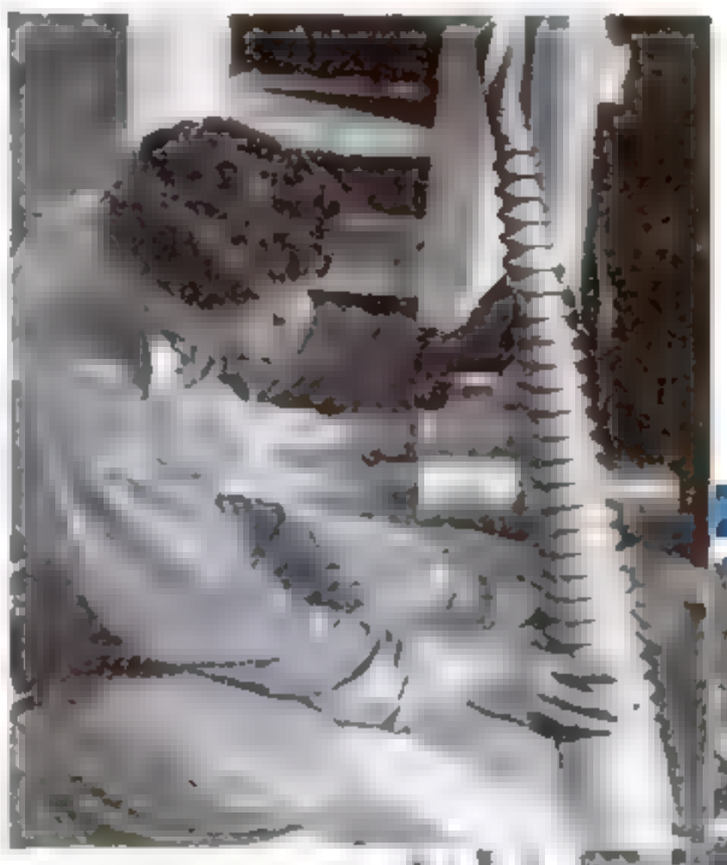
Now the fishing crew attached a tool resembling an octopus. Slowly it descended to the depths. Long steel tentacles reached out to explore the hole. When they returned to the surface, they held the offending sledge in their tenacious grasp. The fat fee the fishing crew received for its emergency "operation" was a well-earned compensation.

One of the commonest drilling accidents is a "twist-off," caused when the bit becomes stuck and "freezes" before the driller has time to shut off the power. And no wonder these accidents sometimes happen! The driller is at the throttle of a steam engine which can develop nearly 1,000 horsepower. The bit turns at the end of a jointed pipe which, in a deep well, may weigh nearly a million pounds. And a vertical two-mile string of six-inch pipe is wiry and flexible. To feed it down smoothly through stratum after stratum of rock, sand, mud, and even bowlders, never swerving nor "crowding it," takes great skill and judgment. Clumsy guiding of these giant forces may easily twist off the bit or part the drill pipe.

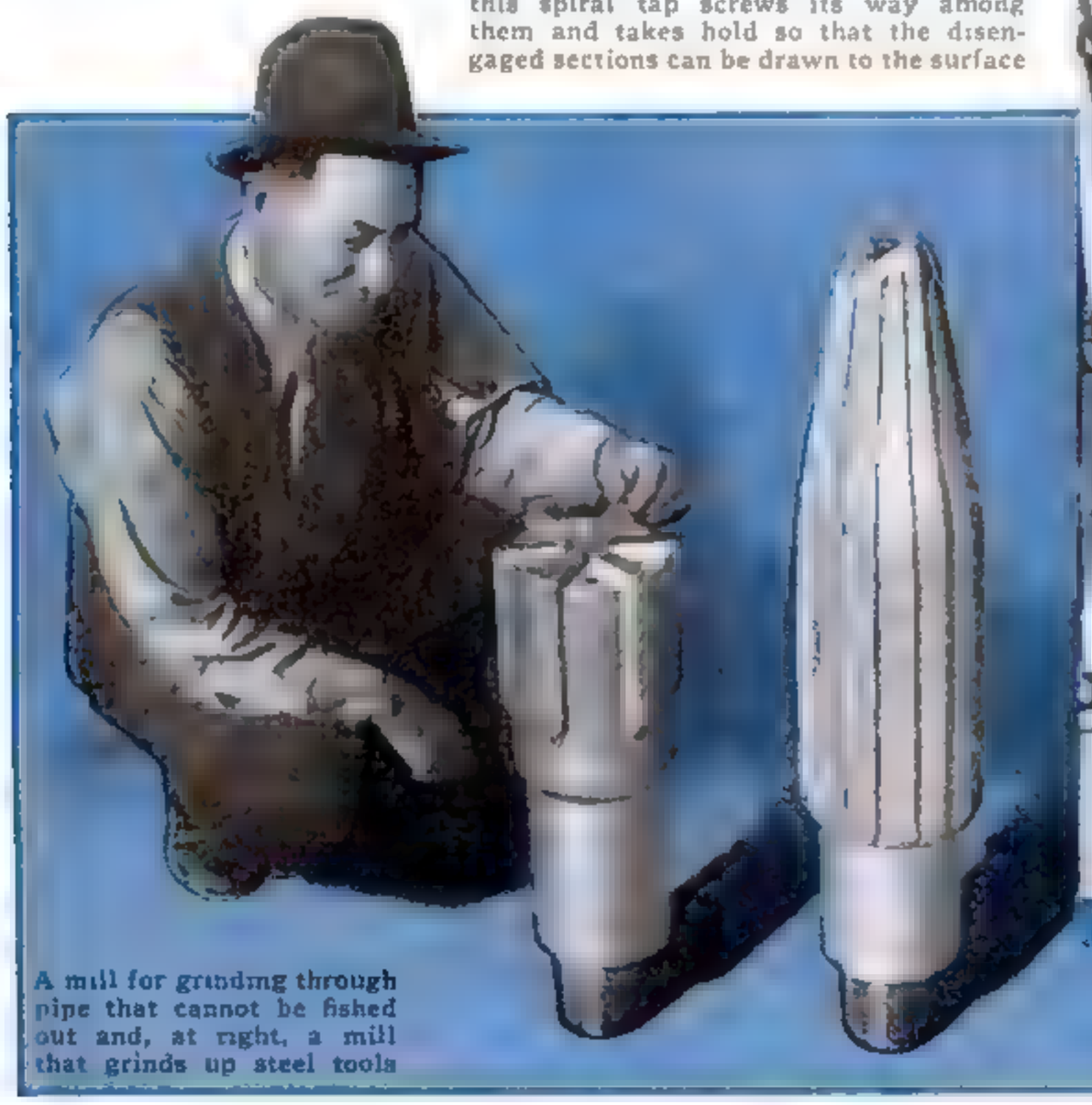
To remove the lost pipe from an ailing well, a battery of strange tools is used, each specially adapted to its particular purpose. Hydraulic hands, nicknamed "dog legs" because of their bent shape, hold the surgical instruments of the fishing crew, permitting them to work around corners in the crookedest holes. Like the storied left-hand monkey wrench, these tools may be used counterclockwise.

SPECIALLY devised fingers called "grabs" delve in the darkness and grasp the most slippery pipe in a grip that defies escape. Dies that cut threads, inside or out, are deftly manipulated to make new couplings for broken pipe. If a casing collapses from too great pressure on the outside, wedgelike swages are driven down to push it back into shape. Or, if it seems better to leave the stub in place and "side-track" past it, powerful knives "amputate" the bulge with a clean, quick incision. Dynamite bombs sometimes are dropped to shoot off a drill bit that cannot be extricated. And if progress is blocked by an object which resists all efforts to dislodge it, hard alloy-steel mills grind relentlessly through the casing, literally puverizing the steel obstacle to let the bit pass.

Wire lines or cables sometimes break and slide down a hole. For this kind of fishing, a harpoonlike shaft of steel with barbs projecting from its sides, is lowered. If these barbs fail to engage the broken line and bring it up, a rope knife is used. Made of special heat-hardened steel, these blades are propelled powerfully through the tangled mass of cable, dissecting it, *(Continued on page 125)*



When a bunch of pump rods gets jammed in a tangled mess at the bottom of a well, this spiral tap screws its way among them and takes hold so that the disengaged sections can be drawn to the surface



A mill for grinding through pipe that cannot be fished out and, at right, a mill that grinds up steel tools

A GIANT WITH A MIGHTY GRIP

Dropped into a large-diameter casing stuck in a well, this big spear grips it with the series of wedging fins indicated by the man's hand, and holds it while it is drawn up

Lacquer Phonograph Disk Is Noiseless

At left, stripping a phonograph record of shreds left by a cutting stylus in the recording process. In the view below, synthetic lacquer is being poured over an aluminum disk by hand to demonstrate its tarlike consistency

Capt. Richard Ranger examining blank records as they come from the machine which applies the lacquer coat

PERMANENT and noiseless phonograph recordings are made possible by a new scratchless record perfected by Capt. Richard Ranger, noted electrical expert. Made of aluminum disks coated with a special synthetic lacquer, the records are produced in commercial quantities in a specially designed, automatic machine. As the disks pass through the apparatus on an endless conveyor belt, synthetic lacquer resembling thin, molten tar pours out of nozzles and spreads over the surfaces in an even layer of uniform thickness. The lacquer hardens in a curing chamber, and the disks emerge from the machine as completed blank records with a clean, polished surface. The top layer of lacquer is so hard and durable that it must be softened before a recording is made; this is done by exposing the disk to chemical fumes in a special "conditioning can." The recording is made while the surface layer is soft, after which the lacquer reverts to its original hardness. The hard top layer is said to eliminate all possibility of scratching or buzzing when the record is played. The lacquered aluminum disks last indefinitely, the inventor claims, and prolonged use will not dull their reproducing qualities.

BALLOON AIDS LUNG EXERCISE

AN ODD breathing balloon, the invention of a Canadian physician, is said to stimulate the lungs and promote chest expansion. The user exhales through a mask-shaped mouthpiece into a rubber bag about the size of a basket ball, and then inhales through the same opening. The carbon dioxide trapped in the bag is inhaled again with, it is said, a tonic effect on the lungs.

BOSS'S MOVING OFFICE KEEPS WORKERS BUSY

WHEN the manager of a European shoe factory discovered that shop work lagged on the floors that he seldom visited, he adopted the novel solution of transferring his office into a special elevator erected against the outside wall of the building. Now, by merely pressing a button, he can move to any floor without leaving his desk or even interrupting a telephone conversation. The arrangement has proved so successful that a new office is planned which will move horizontally as well as vertically.

In this elevator office, a factory manager visits all working floors

"FISH POLE" DISPLAYS LIGHTING FIXTURES

LIGHTING SALESMEN now "fish for business" with a collapsible rod used to demonstrate ceiling fixtures. The rod is made of jointed sections of lightweight metal and can be extended to any ordinary ceiling height. In a prospective customer's store or office, the salesman attaches a ceiling light to one end of the rod, plugs the connecting cord in to a wall outlet, and demonstrates the lighted fixture in place against the ceiling.

Mile-a-Minute Pigeons..

"Old Faithful," a thoroughbred of the air, one-time winner of the Chattanooga National, the annual classic of the pigeon-racing world

..THRILL MILLIONS IN RACES AGAINST TIME

By Edwin Teale

STREAKING through the skies with the speed of crack express trains, feathered racing champions, trained by amateur pigeon fanciers, are shuttling across the map on amazing flights. In recent years, the sport of pigeon racing has spread rapidly. In the United States alone, upwards of 10,000 amateurs own lofts, and each year the American Racing Pigeon Union sends out half a million numbered aluminum bands that go on the legs of newly hatched "squeakers."

As this is written, all over the East and Middle West fanciers are grooming their prize birds for the Chattanooga National, the Kentucky Derby of the air. This annual event, held about the middle of June, sometimes attracts as many as 1,700 entries. Last year, a one-year-old male pigeon, which had never won a contest in its life, carried off the prize. It averaged almost fifty miles an hour for the 535 miles from Chattanooga, Tenn., to its home loft at Washington, D. C.

Picture the start of this race, a few weeks hence. In special crates, the birds arrive at the southern city. They come from country estates, small back yards, farms, city roofs. Farmers, millionaires, mechanics, bookkeepers—almost every walk of life you can mention is represented among their owners.

Just at dawn, you hear the crack of the starter's pistol. Officials fling open the doors of the crates. From each opening pours a torrent of wings. In a great cloud, the pigeons whirl over the field in widening circles. Then you see a bewildering demonstration that represents a great unsolved mystery of nature. The cloud breaks up and, in small bevies, the birds scud away—some north, some south, some east, some west—each heading unerringly for its home loft at least half a thousand miles away!

The birds rarely fly in a bee line. Instead, they take the easiest course, often following valleys where wind resistance is less. Mile-a-minute speeds are common, and one fleet-winged American bird averaged seventy-one miles an hour over a 300-mile course. Storms may delay them, hawks may swoop down upon them, hunters may fire at them. But, if they escape, they fly on. During the World War, more than ninety percent of the U. S. Army Signal Corps birds reached their destinations.

A few years ago, a Signal Corps pigeon, the "Topeka Hen," set a distance mark, winging its way more than 1,200 miles from Topeka, Kans., to the government loft at Fort Monmouth, N. J. It had been sold to a Kansas fancier and had escaped from its new owner

Another remarkable instance of the homing instinct of these birds is reported from eastern Canada. A racing pigeon, long given up for lost, fluttered down at the home loft near Montreal. It apparently had dropped exhausted into a yard

Large wicker baskets are used to ship the racing pigeons by express to the starting point of a race. The feathered blue bloods are timed as they fly homeward

This ingenious machine fastens identifying bands on the legs of birds entered in a race. Each band has a symbol on the outside, and a secret number within

The "hand toss," used in launching pigeons for training flights. The bird is held in the manner shown and thrown into the air with a gentle motion

A homing fowl entering its trap at the end of a race. It has been trained to push through the door

during a race, had been captured and had had its wing feathers clipped. Waiting for weeks until the feathers grew out, it escaped and flew home. Sometimes, birds put in an appearance after months have gone by. A pigeon on its first training flight in California took four months to get home, and another was away for a full year.

Queerest of all tales about the feats of these remarkable birds is the experience of a West Coast fancier. He presented two racing pigeons to a friend who lived a couple of miles away. The new owner trimmed one wing of each bird and placed them in a pen with his show pigeons. Three hours later, the original owner was astonished to see the birds walking about in his own back yard. Unable to fly, they had walked the whole two miles home!

Incidentally, if you find an exhausted or injured homing pigeon, copy the number on the aluminum leg band and report it to the American Racing Pigeon Union, 214 Congress St., Jersey City, N. J. This organization will get in touch with the owner. The bands are placed on the "squeakers" when they are five days old, and the legs grow and hold the rings solidly in place where they remain as long as the birds live. The same pigeon carries the same number throughout its life.

As early as the time of King Solomon, 3,000 years ago, the sport of flying homing pigeons was well established. During the Golden Age of Greece, news of the Olympic Games reached outlying cities through use of these swift couriers of the sky. For more than a century, there was a regular pigeon post at Bagdad, and when the knights of the Crusades rode to the Holy Land they took falcons to intercept messages carried by the homing birds of the Saracens.

Messages, letters, and even whole newspapers were photographed on thin collodion film during the Franco-Prussian War and thus sent out from the beleaguered city of Paris by pigeons. A single bird, in this way, could carry as many as 30,000 words. And it was homing pigeons, winging their way through smoke and shellfire in 1918 that brought help to the Lost Battalion in the Argonne.

JUST a century before that, in 1818, the first great pigeon race, the classic Belgian Concourse, was held at Brussels. This annual competition, in which the birds fly 500 miles starting from Toulouse, France, is now a national institution comparable to Derby Day in England. In the United States, the sport received fresh impetus in 1910 with the formation of the American Racing Pigeon Union. From coast to coast, clubs affiliated with this national body hold races for old and young birds and for distances ranging from 100 to 1,000 miles. In one New Jersey race, last year, 5,000 pigeons competed. During the last quarter of a century, American pigeons have won cash prizes totaling $94,000.

There are several ways you can get into this fascinating sport. You can buy old birds and raise your own young ones. You can buy eggs and hatch them out under ordinary pigeons. Or you can purchase the squabs, or "squeakers," and raise them to maturity. The prices of racing pigeons run from $5 to $200 a pair. The highest price ever paid for a single pigeon was $1,086. The sum was given by a fancier from Louisville, Ky., for an English race winner in 1921. In another instance, a racing pigeon fan traded two descendants

Below, the racing band is being removed from the bird's leg. This is done at once to register the time of arrival

of a prize-winning bird for a large block of valuable oil stock.

Unique among these flying money makers is "Old Nick," a four-year-old racer which is putting its owner, young Leonard H. Murray, through college!

Some years ago, Murray found a stray pigeon with a band on one leg. He got in touch with the owner and through him became interested in the hobby of breeding racers. He now has a loft of nearly forty fleet-winged birds, among which the most consistent winner is Old Nick. The prize money collected by this bird alone has been sufficient to put Murray through a year at the University of Minnesota.

In the early days, pigeon racing was a haphazard sport. Now, it is scientifically conducted with the aid of a dozen ingenious mechanisms and devices. Training is a matter of infinite care, and pigeon breeding is a lifetime work.

Special racing rations, containing corn, Tasmanian peas, vetch, and other grains, put the birds in tiptop condition. They eat about a pound of food each week, plus about fifteen percent of the food weight in grit. Sometimes, during the racing season, the birds are given a special relish of canary seed and a little hemp seed before their regular feed. Occasionally, table rice is added. During the moulting season, one or two percent of flaxseed is included in the diet.

To keep his birds in racing trim, one noted Canadian fancier gives them little bricks to peck at. He makes the bricks by crushing up egg shells, white millet seed, a block of magnesia, pieces of cuttlefish bone, a red building brick, and oyster shells. Adding anise seed, air-slacked lime, and iodized table salt, he sprinkles the mixture with water until it forms a mud-like paste. Then it is molded into small bricks and baked for sixty minutes in an oven. A fresh bit of the material is supplied the pigeons each day.

The nests where the young squeakers hatch from the eggs are usually bowls filled with shavings, straw, or tobacco stems. Cedar shavings are best. One of the first problems is to keep the breastbones, or keels, of the young pigeons straight. In its early cartilage form, the breastbone is easily bent or deformed. During the first eight or nine days, however, a deformed keel can be straightened by massaging it with the hands.

The ideal racing pigeon has a broad skull, a long face, and a V-shaped bill. A full-grown male pigeon will weigh from fifteen to eighteen and a half ounces; a female from thirteen to seventeen. The birds are at their peak for racing when they are three years old. Some are still strong contenders when they are seven or even ten years old, and one 1,000-mile champion owned by an eastern fancier is still flying at the age of eighteen!

Even before the young pigeons have tried their wings, they are taken from their parents and their training begins. Through association with their favorite foods, they are taught to walk from the landing board into the loft. As soon as they take to the air, training begins in earnest. The first trip away from home occurs on a clear morning, before the birds have been fed, and they are released a mile or so from the loft. At the end of this and every other training trip, they find food awaiting them. Gradually, the distance of the homing flights is stretched to twenty, thirty, eighty miles. Then the birds are ready for a 100-mile race, then a 300-mile race, and finally a 500-mile competition, with perhaps the 1,000-mile marathon as a final test.

Oftentimes, to save expense, a club will hire a truck and take hundreds of birds together on a training trip to some distant point. However, the "single toss" method, in which each bird starts for home by itself, is considered the best training for youngsters. Some fanciers paint the roofs of their lofts a distinctive color to aid the birds in recognizing more easily their home destinations.

In addition to colored roofs, the mobile

TEACHING BIRDS TO "CHECK IN"

A typical pigeon loft, that of A. Heuvelmans in Forest Hills, N.Y. Returning from training flights, the birds sometimes do not enter the trap promptly and have to be chased in with a short stick like the one seen here

How winged racers "punch the clock." The racing band from the bird's leg is put into a metal container, as shown above. This is slipped into an opening in the timing clock at right, and the crank turned to register the time

The interior of the timing clock. Each of the ten compartments on the disk will register the arrival of a bird

In training cages like this, young pigeons are taken for ever-increasing distances from home

A racing pigeon's wing, outstretched, should form a straight line as above

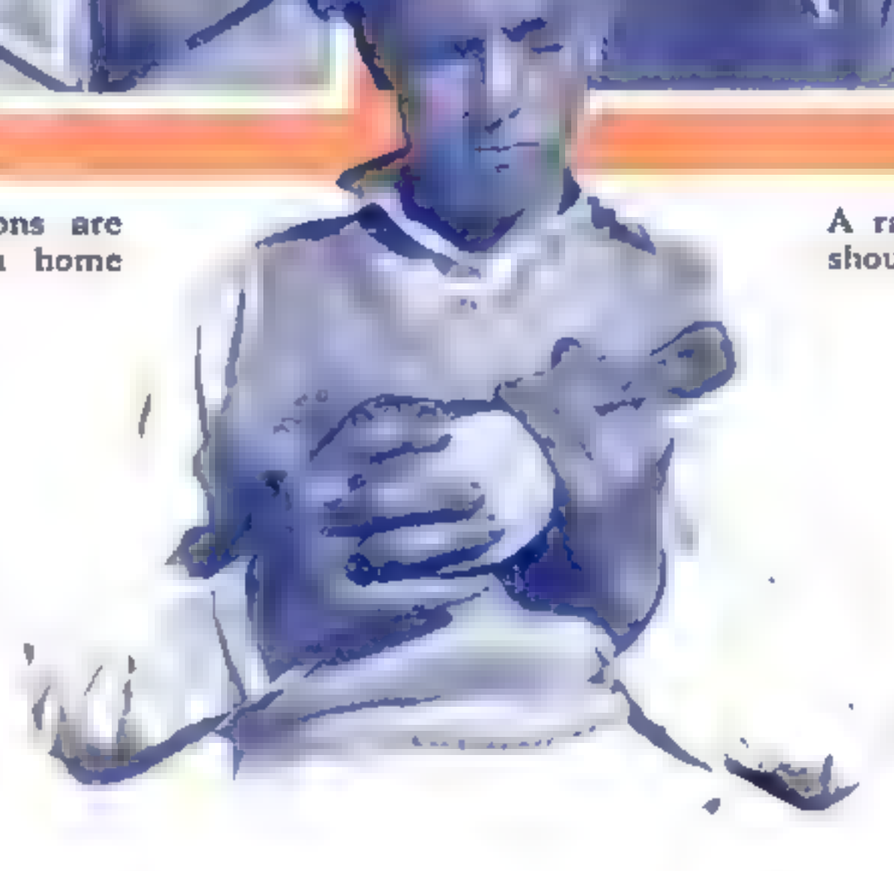
lofts of the U. S. Signal Corps have distinctive combinations of lights to guide night-flying homers. Such birds, developed by carrying the training hours later and later into the evening, would be of great value in warfare, as they could slip over the battlefield unseen in the darkness.

To get their pigeons accustomed to rain, many fanciers drive them from the loft during showers and make them fly under all the conditions they are likely to meet in an actual race. One expert makes it a practice to chase his birds around inside the loft to develop their wind in preparation for a big contest. He got the idea some years ago when his homers made a particularly fine showing in a race; a cat had got into the loft, the week before, and had chased the birds for nearly an hour before it was discovered.

In selecting birds to compete, some trainers not only take into consideration the experience and appearance of each bird, but also check up on its rate of respiration and its temperature. Only the pigeons that are in prime condition ride in the wicker crates that carry birds to the starting point of a big race.

At the end of every training flight, the birds are taught to trap themselves. That is, they walk into cages containing food, by pressing against wire bars which fall into place behind them. No matter how fast a racing pigeon may be in the air, if it is a poor trapper it is of little value in a competition. To understand why, let's watch the final, exciting moments of a big race.

You take your place in the loft beside the owner. Because the returning birds are tired and nervous, you have to keep out of sight or they may not land. One famous fancier, A. Heuvelmans, who has been racing pigeons for forty-five years, has a special compartment in his Forest Hills, L. I., loft equipped with blue-glass windows through which he can see out,



A young fancier examining a racing bird. He is holding it in such a way as to prevent struggling

while the birds cannot see him. Here he awaits the return of his entries.

A distant speck in the sky grows larger, second by second. At a mile a minute, the homing bird is speeding toward you. The exact distance from the starting point to each loft has been figured out in yards and the winner is the pigeon making the highest yards-a-minute speed. Thus, differences in distances are taken care of in the computations.

The instant the bird drops to the loft and enters the trap, the owner goes into action. Reaching in, he grasps the pigeon and strips from its leg the rubber band which carries its racing number. This band was placed on the bird by officials at the starting point. It contains a key letter as well as a number and, inside, printed in special ink, a second secret number. The same two numbers and key letter appear on a folded piece of paper that the officials keep. At the end of the race, unless numbers and letters on the band and on the paper tally, the bird is disqualified.

Slipping the band into a small folding metal capsule, the owner quickly drops it through a hole into a sealed timing mechanism and jerks a handle. This automatically stamps the time on a strip of paper and moves another tiny compartment under the opening ready to receive the band of the second pigeon to arrive. In this way, the bands and arriving times of all the birds reaching a given loft are filed and recorded. Then the mechanism, still sealed, is turned over to the judges.

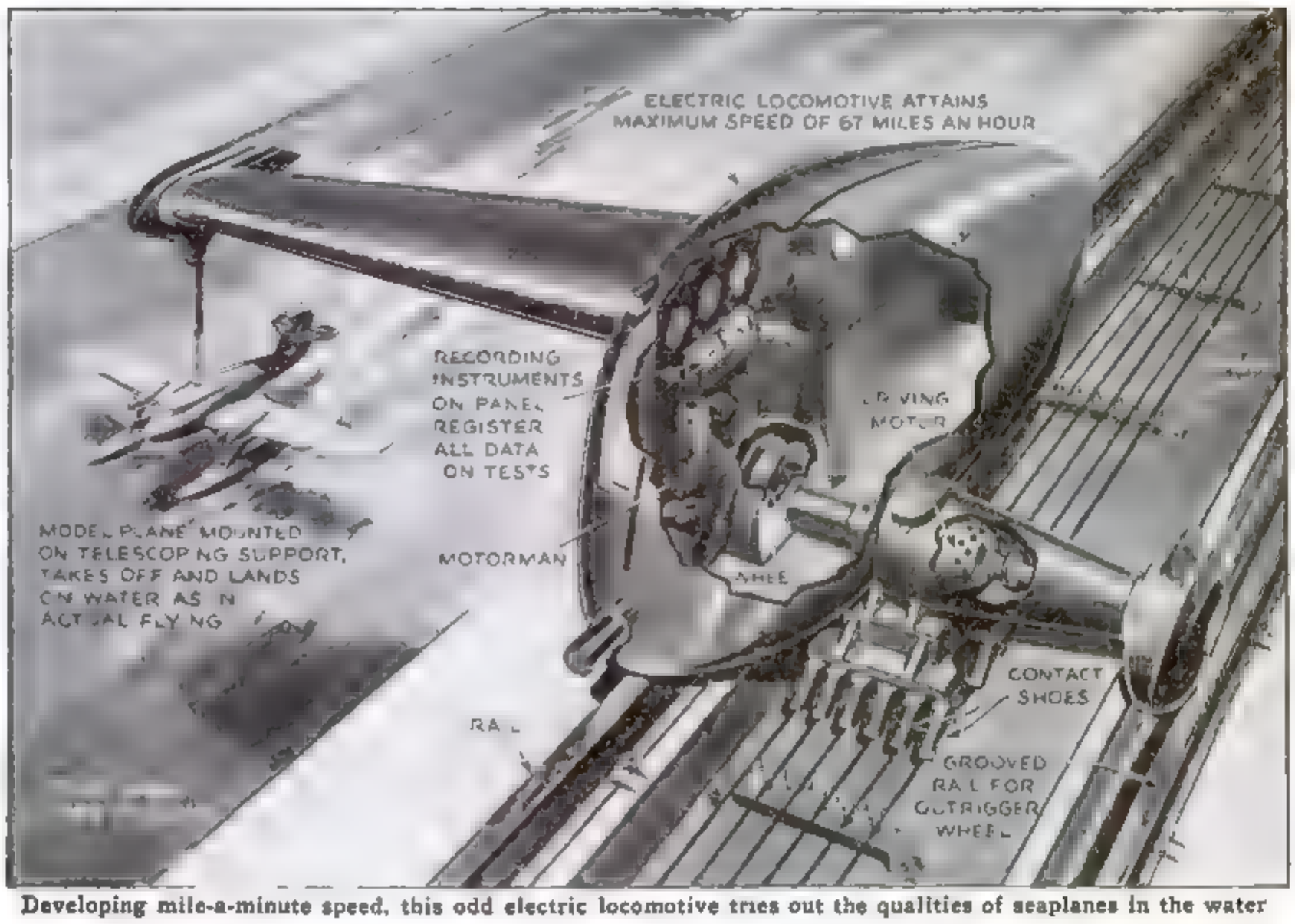
Most fanciers own their own "clocks," which cost in the neighborhood of fifty dollars apiece. Before a race, they are all set and inspected by the officials. No bird has finished his race until his leg-band is in the timing mechanism. Hence, the importance of having the pigeons trap themselves instantly on their arrival.

A couple of years ago, Edward Barnes, Secretary of the American Racing Pigeon Union, entered a fleet-winged but erratic bird in the Chattanooga race. It came scudding toward the loft at top speed, circled it twice and then dropped down on a neighboring roof where it perched for more than an hour before it entered the trap, by that time hopelessly out of the running. *(Continued on page 122)*

Permanent identification bands, like those seen below, are put on the legs of young "squeakers"

Fast Locomotive Tows Seaplanes in Tests

TO AID in developing improved types of seaplanes, one of the world's most elaborately equipped testing basins has been placed in service at Guidonia, Italy, where an aviation-research center has recently been established. Models of aircraft up to sixteen feet in wing span are towed along the surface of water in a 1,450-foot tank by the streamline electric locomotive illustrated at the right, which can attain a speed of more than a mile a minute. Instruments on a panel within the cab enable engineers to study the performance of the model and rate its efficiency in terms of stability, resistance to passage through the water, and other factors. A second locomotive of slower speed, and of more conventional design, straddles the twenty-one-foot width of the basin and is used for towing hulls and full-size pontoons.



Developing mile-a-minute speed, this odd electric locomotive tries out the qualities of seaplanes in the water

Steam-driven airplane starter in use at Wright Field, Dayton, Ohio, where it was developed

AIRPLANE STARTER POWERED BY STEAM

POWERED by steam, a novel starter for airplane motors has been developed by Army engineers. Its boiler, a copper coil heated by a gasoline torch, turns a trickle of water instantaneously to vapor and produces eighty pounds of pressure within three minutes, regardless of weather conditions. The steam runs a four-cylinder engine that spins a standard inertia starter. Mechanisms of this type, which engage the crankshaft of an airplane motor after a flywheel has acquired sufficient momentum to turn it over several times, have previously been operated by gasoline motors, but the latter are not always effective as they themselves have been hard to start in cold weather.

SMALL BENDING JIG HELPS SHAPE METAL

HANDY for model builders and home craftsmen, a small bending jig has been introduced for shaping strap iron, rods, and other metal stock. The accessory is clamped in a vise, a cam is adjusted to one of six positions, and metal is bent to the desired curve between the cam and a stationary post, as illustrated above. Heavy stock must be heated before bending.

FUSE LIGHTS TIRE PATCH

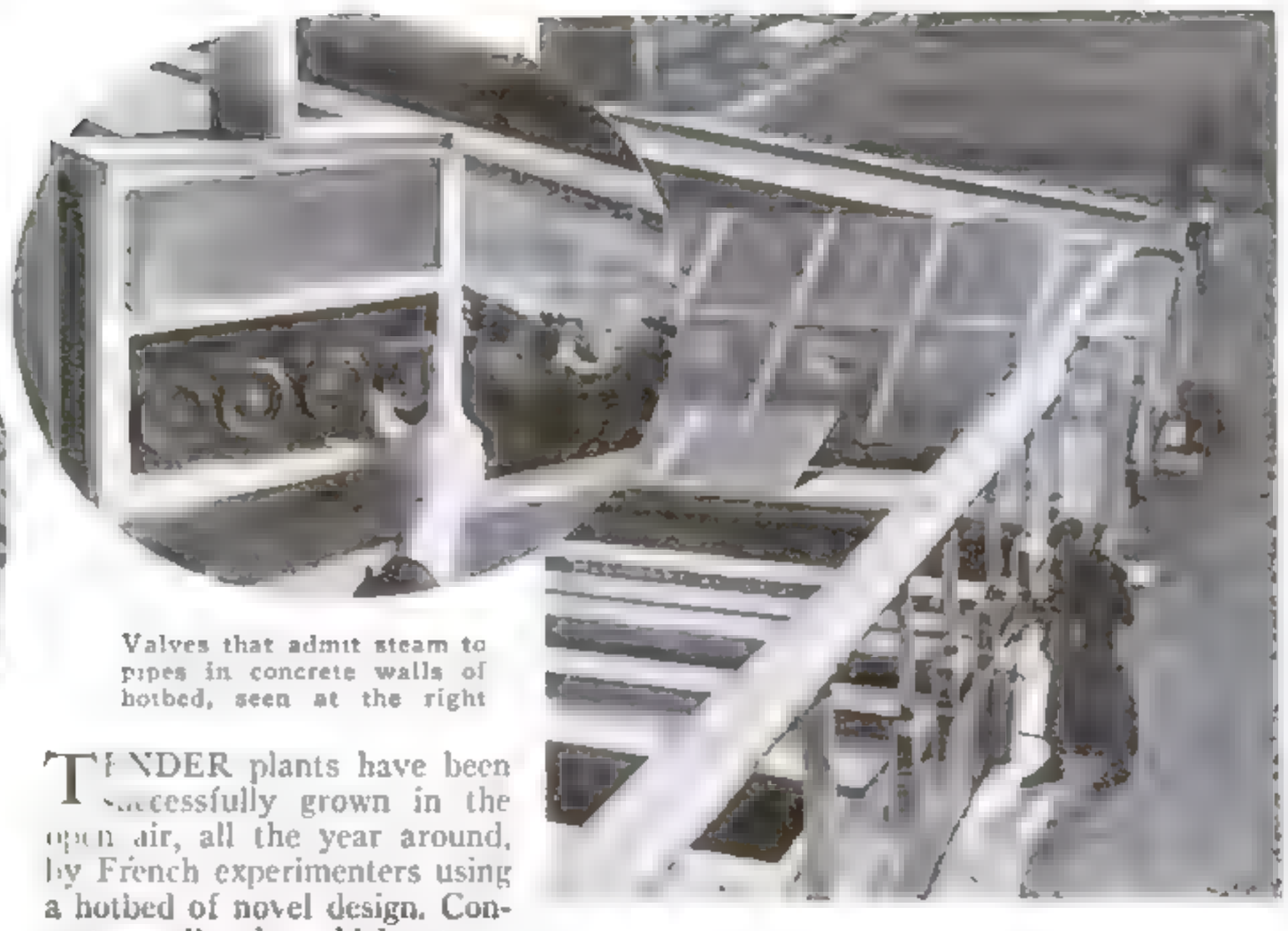
A NEW vulcanizing patch for auto tires is provided with a fuse that ignites its combustible heating material squarely at the center. The even spread of heat resulting is said to assure an even, secure bond.

COLOR "SAMPLES" SENT BY CABLE

SPECIFICATIONS of colors decreed by Paris or London fashions may reach this country in minutes, instead of days, through a system devised by a New York engineer. Standard color disks are adjusted in a viewing device, shown at right, so that when spun rapidly they blend into the shade to be transmitted. Instructions in the form of code numbers, sent by cable, enable the operator of a twin machine to adjust similar disks, set them whirling, and see the color reproduced.

Spinning color disks, the operator sees the exact shade specified in a cable from his agent

HEATED WALLS WARM ROOFLESS HOTBED



Valves that admit steam to pipes in concrete walls of hotbed, seen at the right

TENDER plants have been successfully grown in the open air, all the year around, by French experimenters using a hotbed of novel design. Concrete walls, in which steam pipes have been embedded, border each row. While the plants receive fresh air, rain, and unobstructed sunshine, they are protected from the rigors of cold weather by the heat radiated from the walls. Both flowers and vegetables have been found to thrive under this treatment, which has been applied to produce out-of-season fruits, vegetables, and some blooms.

SAW CUTS TREES OFF CLOSE TO GROUND

AN INGENIOUS one-man sawing machine demonstrated in Germany fells trees without leaving stumps sticking up from the ground. The machine is chained to a tree trunk so that its oval blade is held in a horizontal position close to the ground level. Through a system of gears, the operator swings the cutting blade back and forth by pumping a vertical handle from side to side. A strong spiral spring holds the blade in close contact with the wood. Mounted on a cart, the saw is easily moved.

One-man sawing machine felling a pole in a demonstration

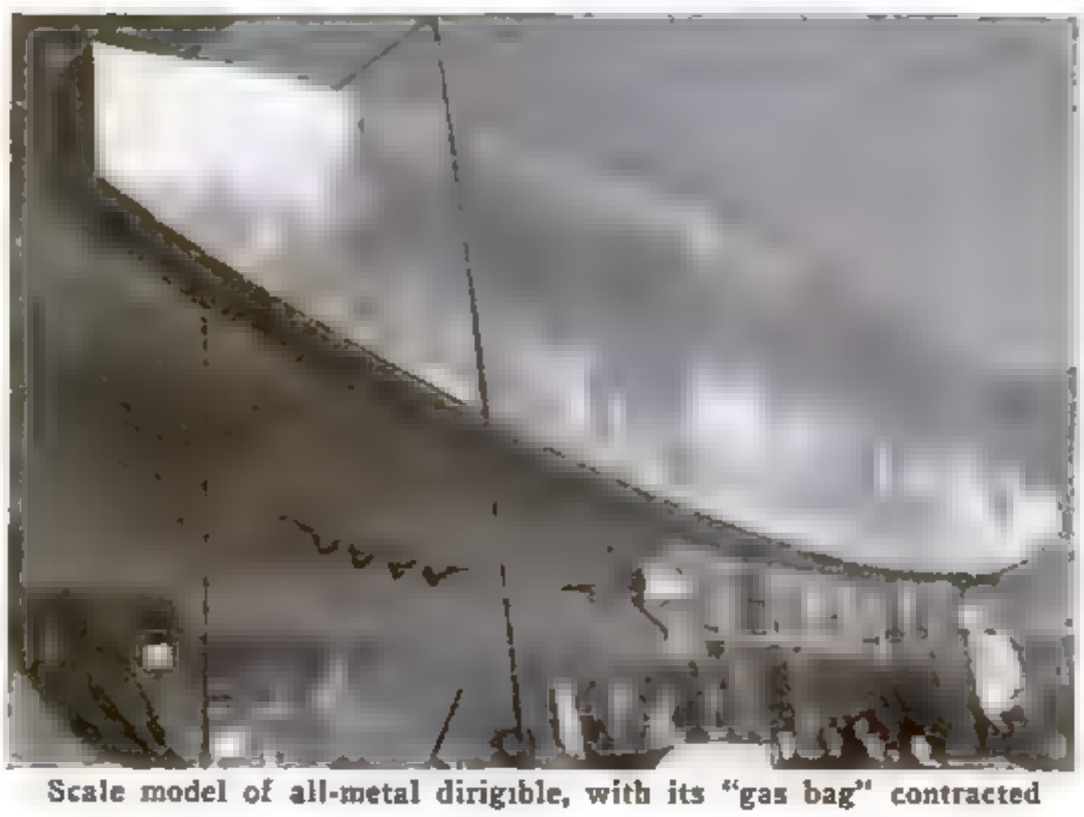
MASKED CYCLIST SOUNDS GAS-ATTACK WARNING

SOUNDING a loud alarm through a loudspeaker clamped to the handlebars of his bicycle, a masked rider wheeled through London streets recently, like a modern Paul Revere, to test the efficiency of a new method of warning the public against sudden aerial gas attacks in war time. Equipped with gas mask and respirator, the cyclist broadcast warnings through a microphone built into the mask and wired to the battery-operated loudspeaker.

PAPER CUP HAS HANDLE

STAMPED from a single piece of waxed paper, a new drinking cup has a convenient handle. After the paper has been cut and shaped into cup form, a thin strip remains attached to the brim. This is turned down and held in a slot where it fits snugly so that cups can be stacked in telescoping fashion. A slight push of the finger bends the strip upward to form a handy and firm handle.

METAL AIRSHIP EXPANDS LIKE BELLOWS

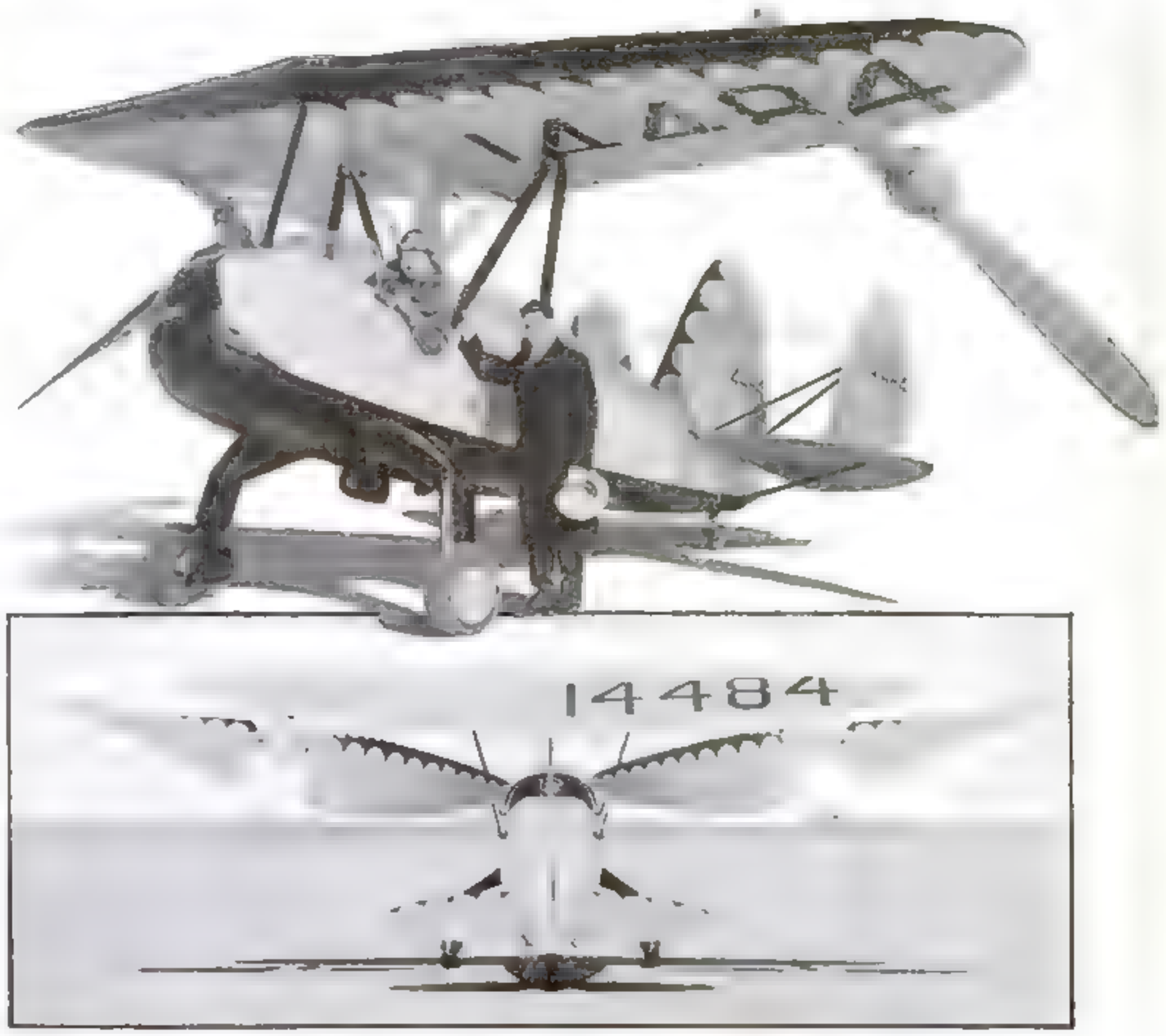


Scale model of all-metal dirigible, with its "gas bag" contracted

LOOKING like some finless ocean monster, a model of a proposed all-metal dirigible has been placed on exhibition in Russia. Constructed of sections of rustless steel, the airship has been designed to act like a bellows. Under normal atmospheric pressure, the ship will take the flattened shape shown in the photograph. As it ascends into rarefied air, the gas-filled envelope will expand into the shape of conventional dirigibles.

WINGS AND PROPELLERS COMBINED IN NOVEL AIRPLANE

WHIRLING vanes on a new plane of radical design furnish a lifting as well as a propelling force. Roughly triangular in shape, the unconventional propellers are mounted on the back of the plane's stationary wing. They are connected to a motor housed in the fuselage behind the pilot's seat. As the vanes rotate, a mechanical device changes their angle at each half revolution in such a way that a propelling action is created with each upstroke and a lifting action with each downstroke. The plane is reported to have taken off quickly, attained a speed of 100 miles an hour, and landed within an exceptionally small area in its initial test flight.



Two views of a new-type airplane in which rotating vanes give both lifting power and propulsion

THREE PIGMENTS SUPPLY ALL PAINTING COLORS

OIL-PAINTING is simplified by three new pigments, perfected by Dr. Herbert E. Ives of the Bell Telephone Laboratories, which yield any color of the rainbow when mixed. Hitherto, artists have had to employ dozens of pigments, and learning how to use them has required long training. In theory, only three "primary colors" should meet all needs, but these were mistakenly supposed to be blue, yellow, and red, which gave unsatisfactory results. Actually, Dr. Ives finds, the true primary colors for pigments are turquoise, yellow, and crimson, of hues meeting rigid spectroscopic tests. Colors prepared from his specifications have been found sufficient for any artist's palette. He has devised a chart and viewing screen to show how to match any shade.

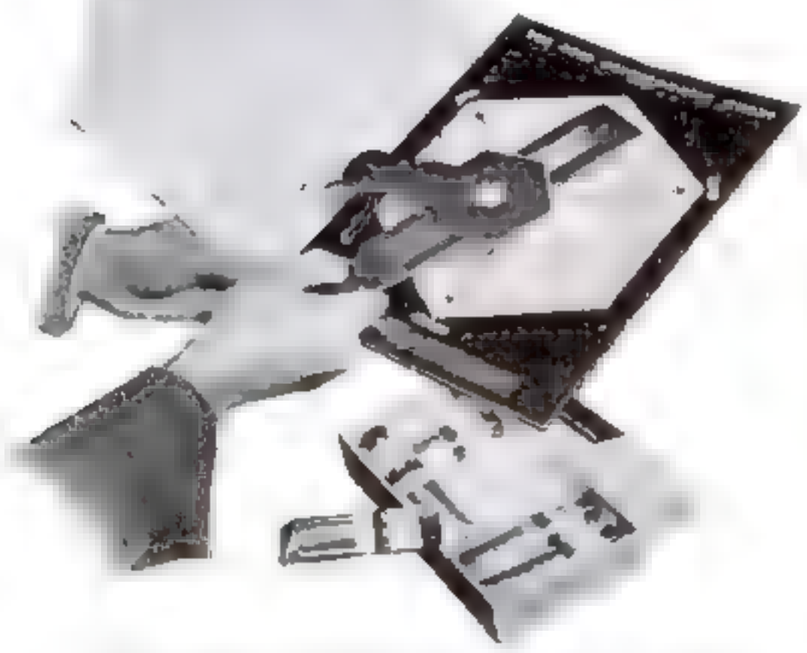


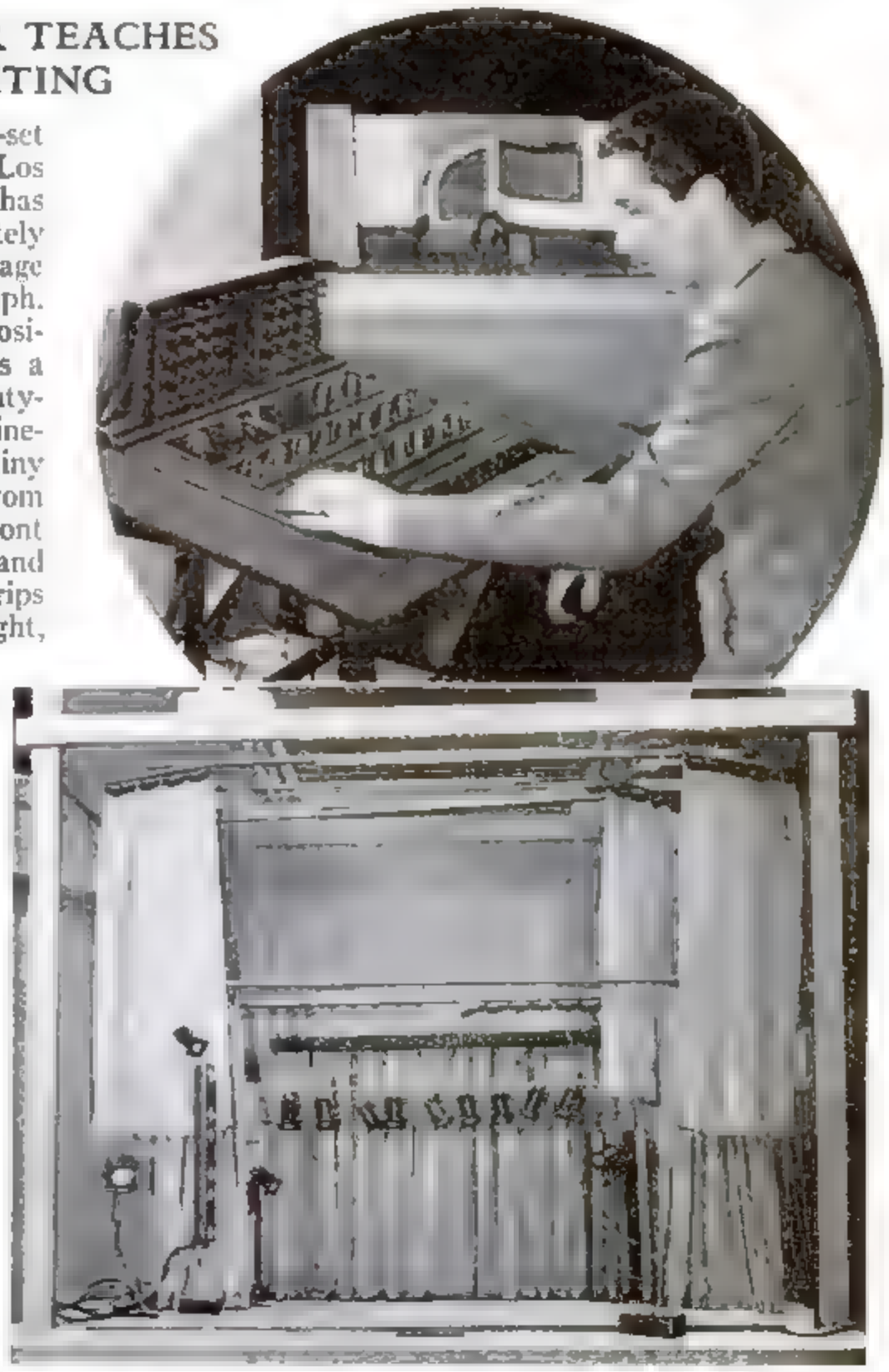
Chart and viewing screen in use to show how to mix colors to produce shade wanted

ODD-SHAPED EYEGLASSES EXPRESS PERSONALITY

"INDIVIDUALIZED" eyeglasses are becoming a fad in England, and makers, departing from the convention that lenses and frames must be round or oval, are producing them in bizarre patterns. A heart-shaped pair, for feminine wearer, is illustrated.

MODEL THEATER TEACHES STAGE LIGHTING

TO DEMONSTRATE stage-set designing and lighting, a Los Angeles model maker has constructed the completely equipped miniature stage shown in the photograph. Built of wood and composition board, the model has a proscenium opening twenty-eight inches wide and nineteen inches high. Nine tiny spotlights are suspended from a light bridge behind the front curtain; panel, border, and flood lights are made of strips of tin and spare flash-light, radio, and electrical parts. All lighting apparatus is operated from a table-type remote-control switchboard equipped with rheostat dimmers. Curtains hang from brass rods and are weighted down with buttons. Stage settings are reproduced to scale from cardboard. From his switchboard, the builder can change backstage lighting to produce various effects.

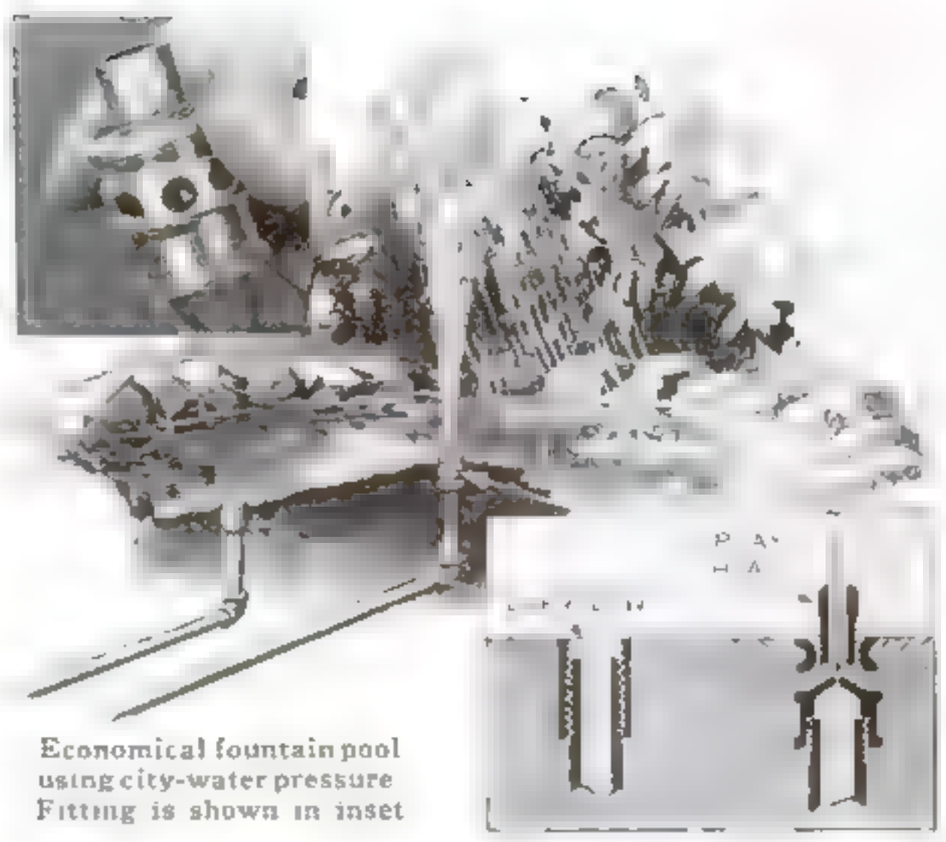


Back-stage view of the model theater, showing lighting equipment. In circle, the builder at the control board

ROBOT RECEIVES BANK DEPOSITS

A depositor using a mechanical device that gives photograph-receipts for valuables

OFFICIALS of British banks recently witnessed a demonstration of a new mechanical aid to depositors. The device, a sort of robot cashier, receives notes, coins, and documents, which are inserted in an aperture as shown in the illustration at the left. Within the apparatus a camera shutter clicks, and in a few seconds' time a receipt is delivered, bearing a photograph of the parcel that has been deposited. Simultaneously, the transaction is automatically recorded and the exact time is registered. Because of the safeguards provided, the system is declared proof against confusion as to the ownership of deposited valuables, and is expected to be of special usefulness for receiving deposits of cash and other valuables outside of banking hours.



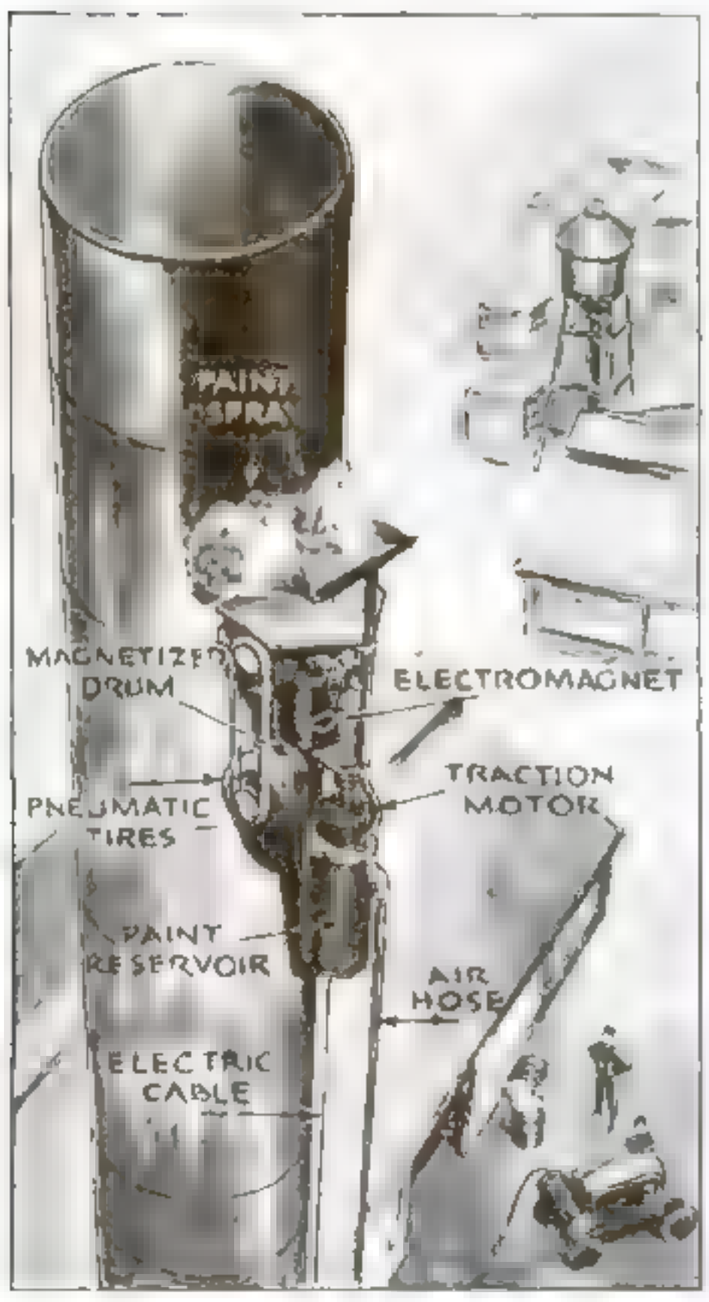
Economical fountain pool using city-water pressure Fitting is shown in inset

FOUNTAIN COSTS LITTLE TO RUN

AN INEXPENSIVE supply of sand, tile, and cement, a few lengths of pipe and a small fitting of new design suffice to create a garden pool graced by a sparkling fountain. Applying the principle of a perfume atomizer, the fitting uses city-water pressure to spray the pool water into the air. The cost of operation, for the pinhole-size jet of city water used, is said to be negligible.

MOSQUITO VEILS WORN IN ARCTIC

DURING the brief summer in the arctic regions, mosquitoes can be as much of a pest as in more temperate climes, Soviet scientists have learned, and veils of netting have become a necessary part of their equipment. The photograph at the right shows a party setting out to explore the hilly fastnesses of Dunai Island, where an observatory has been established.



MACHINE PAINTS STACKS

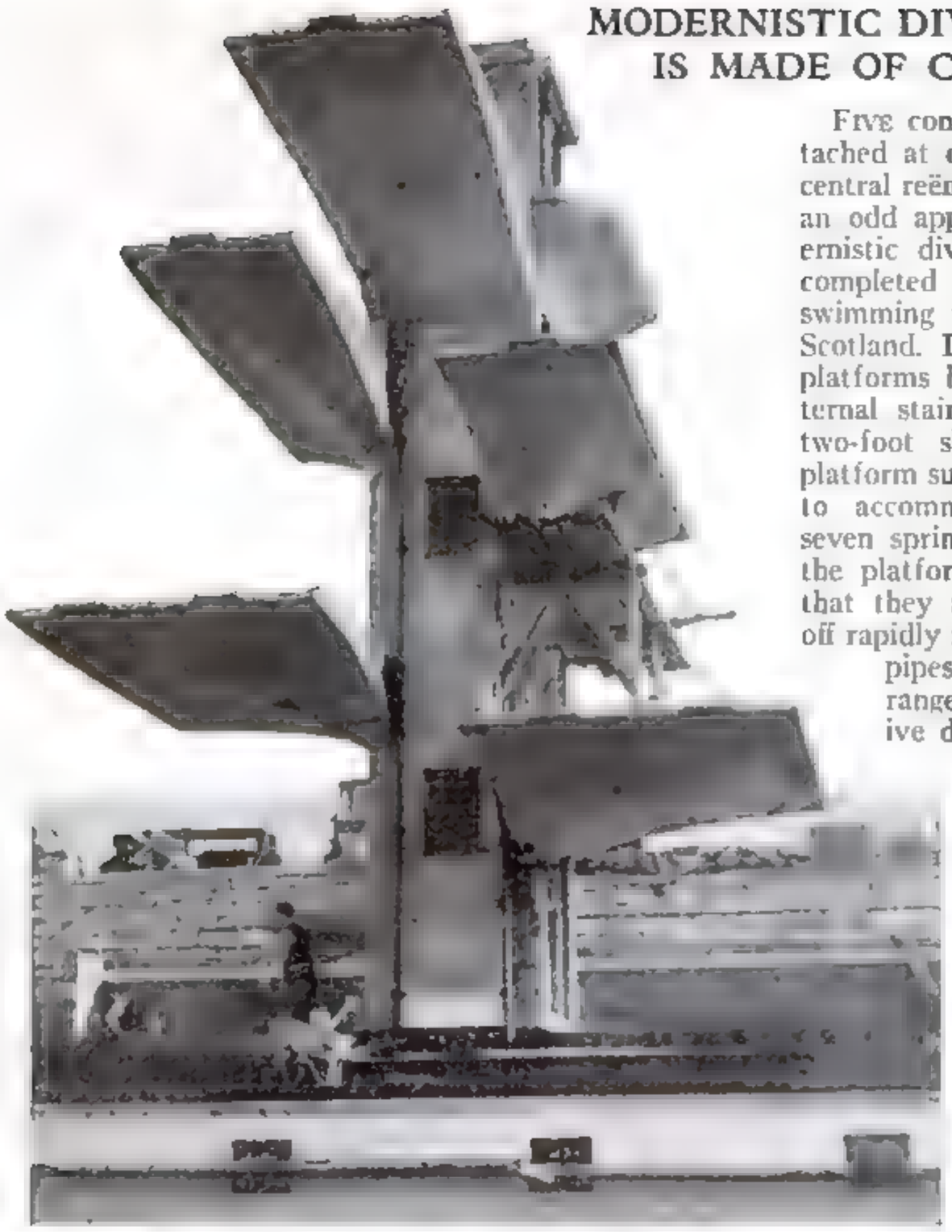
A MECHANICAL steeple jack for painting tall metal smokestacks, recently invented, would relieve workmen of this dangerous task. Magnetized drums enable it to cling to the stack, like a fly on a wall, as it runs up and down under its own power. An operator on the ground controls its movements and the operation of its paint-spraying nozzles by means of its trailing electric and air cables.

ONE-MAN THEATER HELPS KILL TIME

TO HELP travelers while away the time when waiting for trains, a one-man movie theater, suitable for installation in railway terminals, has been designed by a New York inventor. Entering the booth of one of these devices, a patron would seat himself before a miniature screen and insert a coin in a slot. An automatic projector would then entertain him with a current film production until he was ready to leave. A number of booths of this type would offer a choice of films.

MODERNISTIC DIVING TOWER IS MADE OF CONCRETE

FIVE concrete platforms, attached at different levels to a central reënforced column, give an odd appearance to a modernistic diving tower recently completed at a new $450,000 swimming pool in Edinburgh, Scotland. Divers mount to the platforms by means of an internal stairway in the thirty-two-foot shaft. The built-in platform supports are equipped to accommodate a total of seven springboards. Floors of the platforms are concave so that they allow water to run off rapidly into concealed drain pipes. The platform arrangement is very effective during exhibitions.



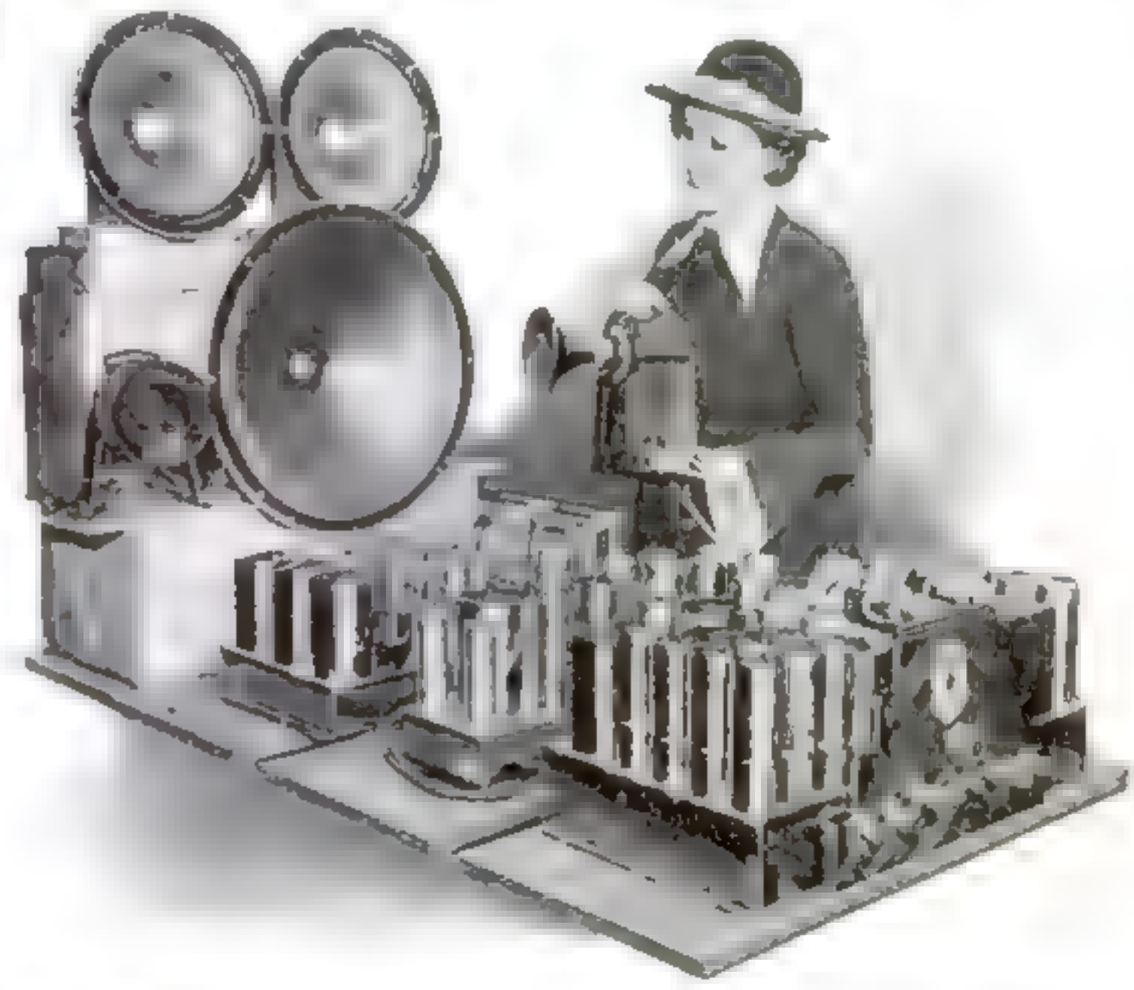
Workmen putting the finishing touches on a novel diving tower at Edinburgh, Scotland. Platforms are reached by a stairway in the main shaft

WATCH-CASE PHONOGRAPH

CALLED the world's tiniest talking machine, a miniature phonograph has been built into the case of a watch. When wound by the watch stem, a small spring mechanism turns a midget record. Sound is reproduced through a diminutive horn.

BIGGEST RADIO SET HAS FORTY TUBES

WHAT is believed to be the largest and most powerful radio receiving set ever assembled is the latest achievement of a well-known Chicago radio engineer. Designed for world-wide reception on all wave lengths, the mammoth receiver has a complicated circuit which employs forty tubes. Five separate loudspeakers, operating simultaneously, cover a wide sound-frequency range, and give exceptional tonal quality. The total weight of the receiver, shown below, is 620 pounds.

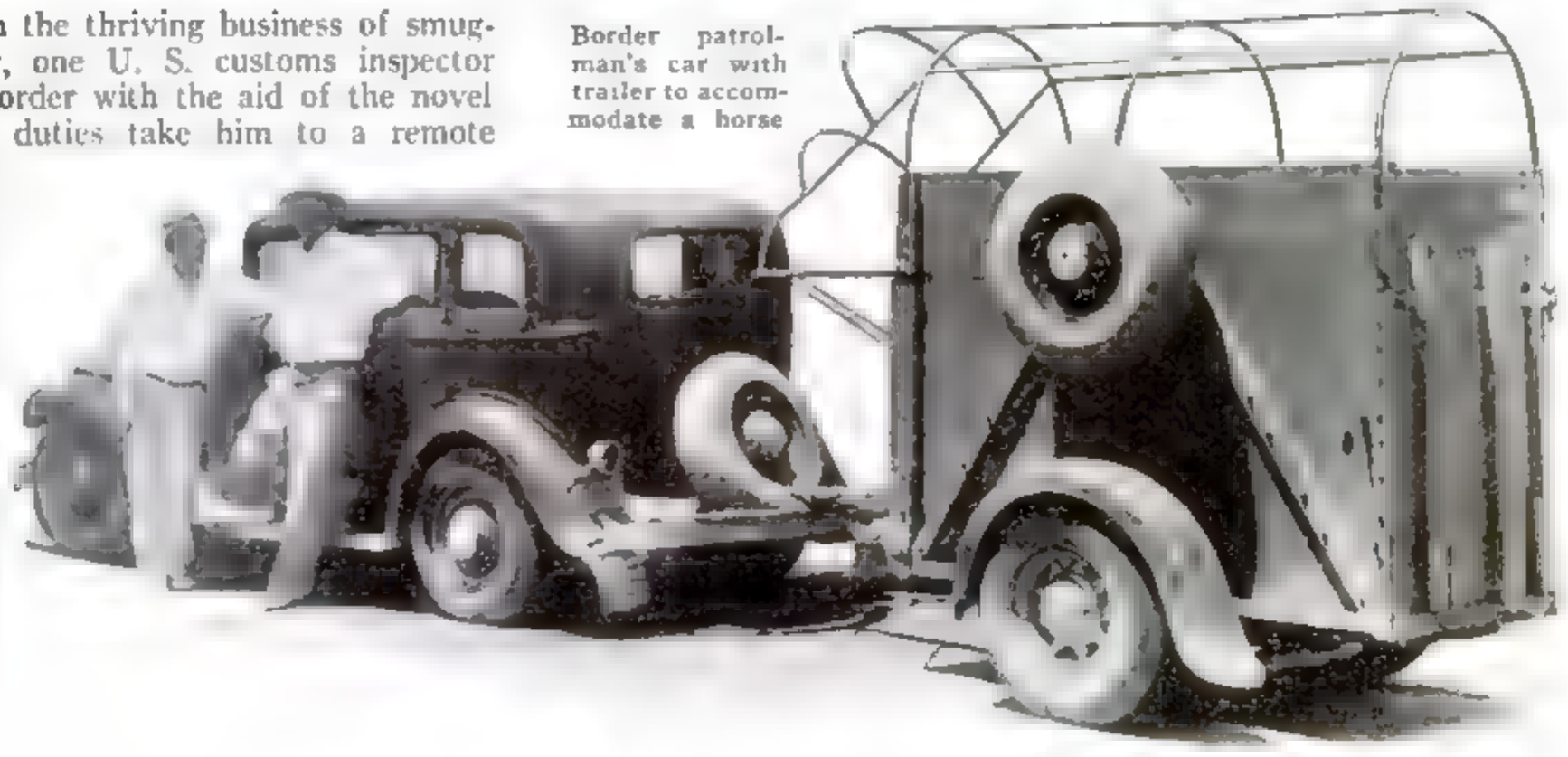


GRINDING PLATES TEST MOTOR OIL

A NEW device for testing the quality of motor oil is now on the market. When a sample of crankcase oil is dropped into the apparatus, it lubricates the surfaces of two steel "pancakes," one of which grinds against the other. The heat generated by the friction is registered on a sensitive thermometer and indicates the viscosity of the tested oil and percentage of foreign matter it contains.

DESERT PATROLMAN TAKES HIS HORSE ALONG IN TRAILER

HUNTING outlaws engaged in the thriving business of smuggling aliens across the border, one U. S. customs inspector patrols the southern Arizona border with the aid of the novel equipment illustrated. If his duties take him to a remote section of the blazing desert country, he drives as far as he can, carrying his horse along in a trailer of special design. When he has arrived at a point where the terrain becomes impassable for motor vehicles, he parks the car and continues on horseback. The scheme enables him to penetrate regions inaccessible to automobiles, and get there far sooner than a horseman could have covered the total distance. Both man and horse are fresh when they arrive where the hunt begins.



Border patrolman's car with trailer to accommodate a horse

Now You Can Fly

By John E. Lodge

The interior of one of the transpacific planes, looking along the fifty-foot aisle of the passenger compartment

Germany's latest and greatest Zeppelin, the *Von Hindenburg*, which will form a link in the globe-circling network of air lines. At the right is shown a typical stateroom on this sky leviathan

OUT of the sky over Lakehurst, N. J., a few days hence, the enormous silver *Von Hindenburg*, biggest Zeppelin ever built, is scheduled to nose down for a landing at the end of its maiden voyage to America. Not many weeks later, the four-engined, twenty-five-ton *China Clipper* will head out past the promontories of the Golden Gate on its first passenger flight to the Orient.

Those two events will forge the final links in a vast chain of airways to encircle the globe. Before the end of this summer, you will be able to buy tickets for an aerial circuit of the earth as easily as you now purchase them for a round-the-world cruise by steamer. Years of preparation, the flights of daring pioneers, and the latest advances in engineering and radio have given a solid foundation to what, but a few short decades ago, was a seemingly impossible dream.

It is only sixty-four years since Jules Verne's classic "Around the World in Eighty Days" appeared in American bookshops. That imaginary circuit of the globe initiated a long series of real-life dashes by train, automobile, boat, and aircraft. Beginning with Nellie Bly's seventy-two day journey, in 1889, and ending with Wiley Post's eight-day flight, in 1933, these races against the clock have dramatized the advancing speed of transportation.

Such stunts, however, were pioneering trips far beyond the reach of the ordinary person. Now, on regular air lines, it will be possible to fly around the world in comfort, following the trail of Jules Verne's hero Phileas Fogg by air. In twenty flying days, and for the price of a high-class automobile, you can make the journey.

The Lakehurst field is the scene of the start. Under the glare of searchlights, the giant *Von Hindenburg* towers higher than a ten-story building and stretches across the field for a distance greater than three and a half city blocks. With nearly fifty other passengers, as well as a crew of forty, you climb aboard the transatlantic Zeppelin. In your stateroom, you find a comfortable bed, electric lights, hot and cold running water. Overhead, the great gas cells hold 7,000,000 cubic feet of helium, enough to lift a weight equal to half a mile of automobiles lashed bumper to bumper!

There is a final inspection, then, at midnight, the com-

TWO NEW AIRWAYS MAKE IT POSSIBLE TICKET FOR A TWENTY-DAY AERIAL

This map shows the course of a journey around the world by commercial air

Around the World

mand: "Up Ship!" The mooring cables drop away, and majestically the immense, silver cigar rises into the air. Almost noiselessly, its four 1,300-horsepower Diesel engines begin spinning their huge propellers. The ship gathers speed. The lights of Lakehurst drop to the rear. At eighty miles an hour, you are heading for the coast. Half an hour later, the vast cluster of pin-point lights marking New York City has slipped beneath you and faded away behind.

The sky liner is taking the great-circle route to Europe, following the trail of Lindbergh. In stormy weather, it would head across for the Azores along a "bad-weather route," 600 miles longer but out of the path of the northern gales. Sunrise finds you well up the coast, and midafternoon reveals the rocks of Newfoundland below. By evening, you are out over the Atlantic making the "down-hill run" to Europe. With prevailing winds at her tail, the big ship rushes on, hour after hour. An occasional steamer, the gleaming peak of an iceberg, alone break the monotony of tossing water. You have time to examine the great aerial hotel on which you are riding, to see the smoking rooms, the shower baths, the electric ranges, and even the full-size grand piano it carries.

By evening of the second day, you are gliding across Belgium, up the Rhine to the new airship shed at Frankfort on the Main. Forty-seven hours after leaving Lakehurst, you step down at the European airport. The fare for this 3,900-mile, transatlantic trip via the airways is $400

In a special "Zeppelin service," all-metal Junkers monoplanes are warming up on the line, ready to carry passengers to Paris, London, Berlin. You board the ship for the British capital, and the steady roar of its twin engines soon lulls you to sleep. Dawn is breaking when you awaken with the machine sliding down for a fast landing at Croydon, the air center on the outskirts of London. The fare for the Frankfort-London hop is thirty dollars.

At London, you purchase an Imperial Airways ticket for a flight to the other side of the globe. The ticket will carry you to Hongkong over one of the longest airways in the world The fare $875 includes meals and incidentals.

For the first leg of this long flight, you ride in a thirteen-ton, eighteen-passenger Hercules airliner. Four 555-horsepower motors pull the 130-foot ship through the sky. From the windows of its spacious cabin you watch smoking factories, the glittering stretch of the English Channel,

One of the clipper ships of the Pan American Airways System. In these four-motored flying boats the round-the-world air tourist will cross the 8,000 miles of the Pacific Ocean in seven days

Captain and first officer in the cockpit of the *China Clipper*. The radio man is behind the panel at right

FOR ANYONE TO BUY A JAUNT AROUND THE GLOBE

lines, with distances and cost. Two new ocean services complete the chain

the green fields of France glide past beneath you. In sight of the Eiffel Tower, the Jupiter engines are throttled down and you land at Le Bourget, the Paris airport, to discharge and take on passengers.

Off again, you leave the French capital behind and slide down across the map of Europe, over the high backbone of the Alps, above the olive groves and blue bays of the Italian seacoast to a landing at Brindisi, at the "heel of the boot" in Italy. Your next take-off carries you out over the fishing fleets of the Adriatic, over the coastline of Greece, above the white columns of the Parthenon, at Athens. Here, you leave the Hercules biplane behind and take your place in the hull of a great fourteen-ton Scipio flying boat for the crossing of the Mediterranean. The second day from London and the fifth from home, you plow to a stop at Alexandria, the Egyptian city founded by Alexander the Great near the mouth of the Nile.

Again, you mount a fresh steed, this time a De Haviland Hannibal. Its quartette of Jupiter motors pull you steadily into the East, over the Holy Land, the Dead Sea, the desert regions of upper Arabia. Below, you see camel trails, caravans, palm groves, towns with low, white buildings gleaming in the sun. By evening, you reach your stopping place for the night, the fabled city of Bagdad, in Mesopotamia.

At dawn, next morning, you head for Basra, at the head of the Persian Gulf, and the following day finds you winging on toward the Orient over strange scenes in Osman, Persia, Baluchistan. Reaching Karachi, at the mouth of the Indus River, you shift to a fast ninety-foot Atlanta monoplane with a cabin specially designed for hot-weather travel. Rice fields, tea plantations, dense jungles, sluggish rivers, teeming villages with brown men rushing out to watch you pass, make up the fascinating panorama that unrolls beneath the wings.

On the flight across India, you stop at Jodhpur, Delhi, Cawnpore, Calcutta, then fly on to Rangoon, in Burma, and Bangkok, the capital of Siam. Swinging south along the Malay Archipelago, your monoplane rolls to a stop on the Georgetown airport at the island of Penang. Here you leave the main line of the Imperial Airways, which runs on another 4,794 miles to Brisbane, Australia—12,754 miles from London. By next year, superfast flying boats, now under construction in England, are expected to clip the time of this long journey in half. The trip to Georgetown now takes about eight days; a few months hence, it will be made in four.

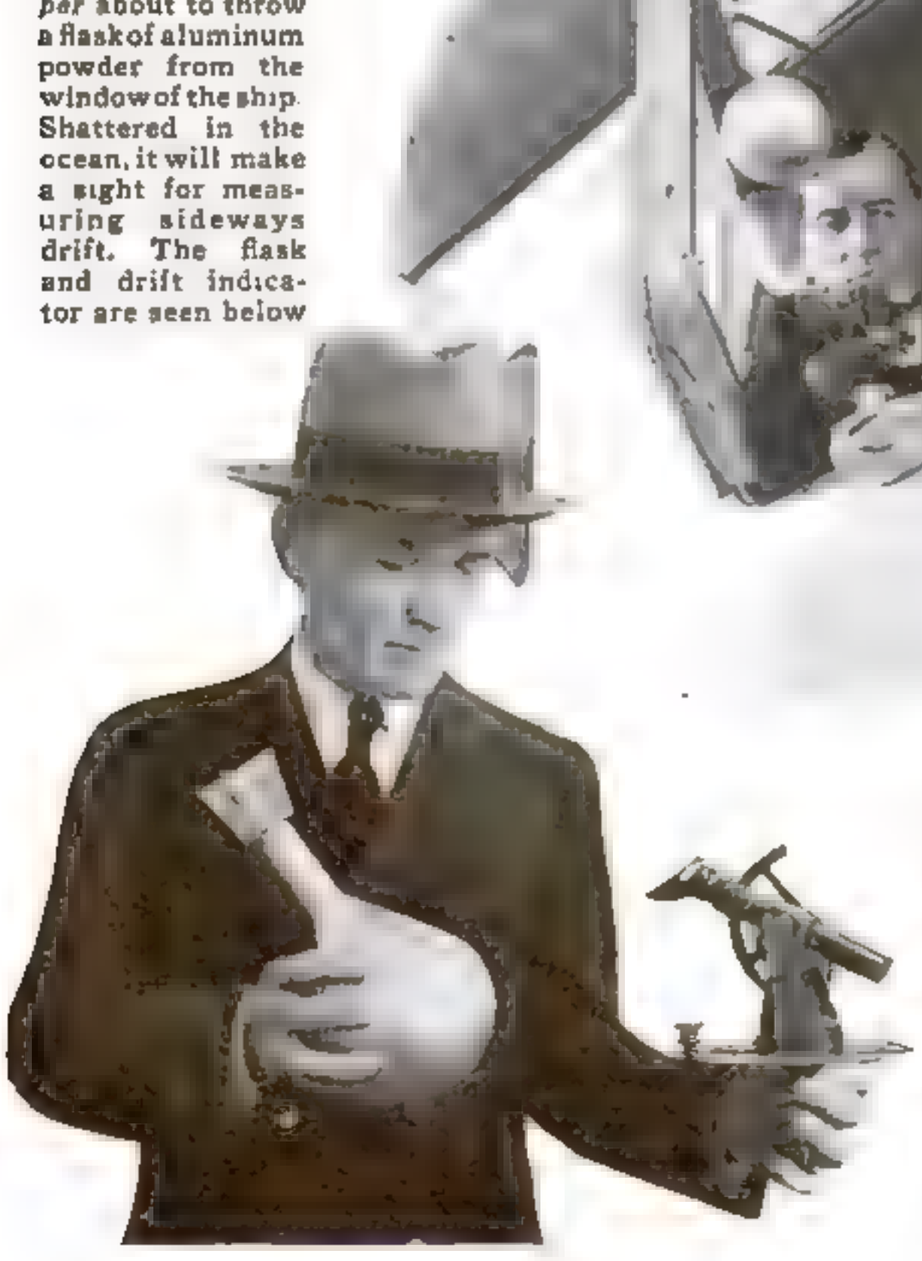
At Penang, you board a shuttle plane for the north, a slim-winged De Haviland "86" powered with Gypsy engines. Crossing the Gulf of Siam, skirting the coast of French Indo-China, heading north up the China Sea, you swoop down for a landing at Hongkong. In twelve days, since that midnight start at Lakehurst, you have traveled 13,700 miles. The total fare has been $1,305.

Across the bay from Hongkong, at Macao, mechanics are tuning up the four 800-horsepower engines on one of the *China Clipper* flying boats of the Pan American line. In these swift transpacific craft, you will travel 8,910 miles to San Francisco by way of the Philippines, Guam, Wake Island, Midway Island, and Hawaii. These ships, and the elaborate precautions which protect them on their long journey, represent a new peak in aerial transportation.

Hundreds of weather stations, in a vast network that embraces half a dozen countries on two continents and innumerable islands of the Pacific, report flying conditions at frequent intervals. These reports form the basis of weather maps that determine when the ship takes off, what course it follows, and how high it flies. Directional radio, developed by Pan American engineers to function over hitherto impossible distances, aids in checking the position of the big boats along the route. Tiny bombs of aluminum powder form floating landmarks by which the navigator determines his drift. And, aboard every ship, a crack engineer sits in a special compartment, surrounded by 107 controls and instruments, adjusting the motors to meet the demands of each section of the flight.

This man, called the flight engineer, knows every quirk and rivet of the big machine. Not only is he capable of performing any necessary repairs, but each hour of the flight he takes seventy recordings, including the rate of *(Continued on page 119)*

The flight engineer in his special compartment, surrounded by the 107 instruments and controls with which he keeps the engines working properly



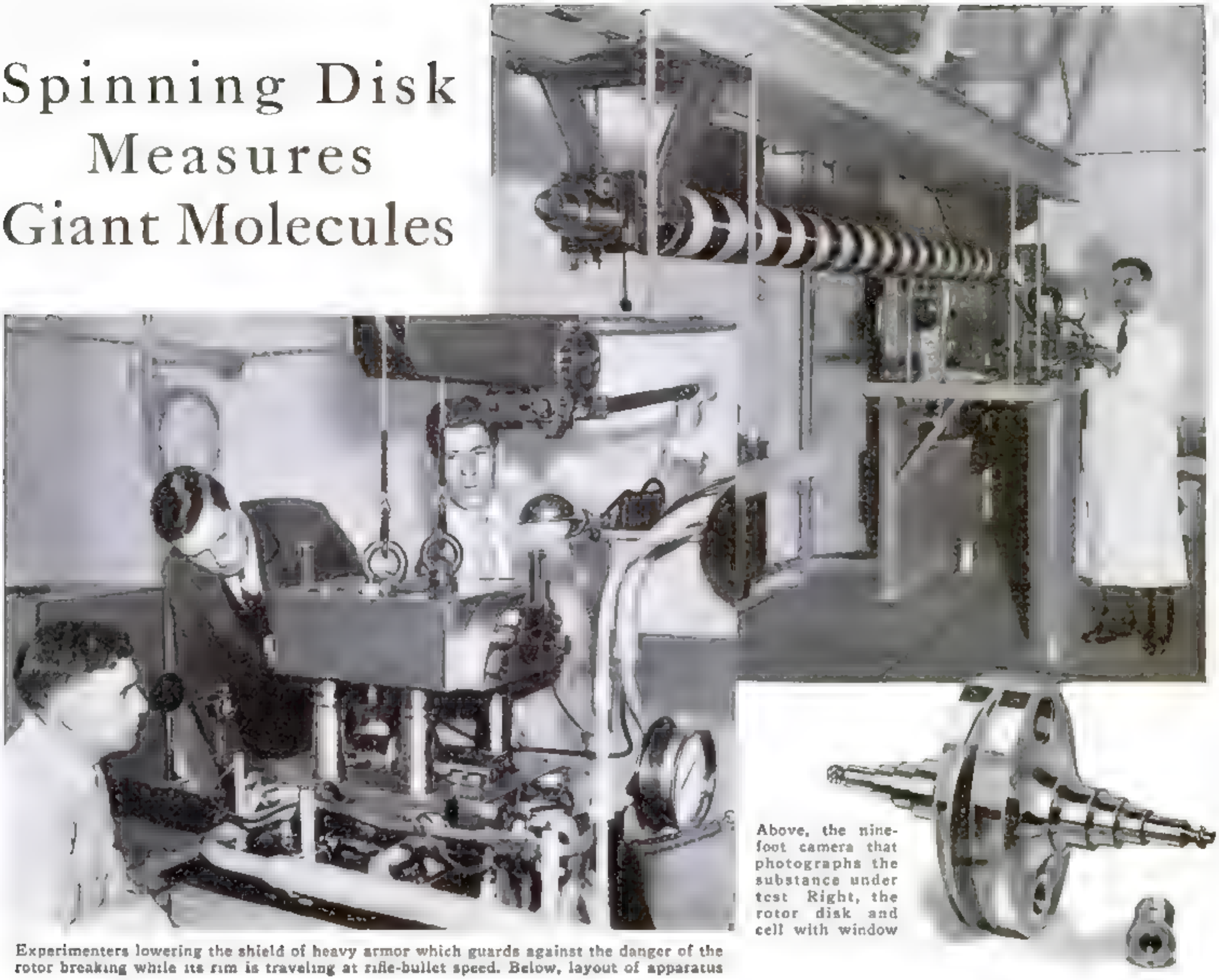
GAUGING DRIFT WHILE AT SEA

Navigating officer of the *China Clipper* about to throw a flask of aluminum powder from the window of the ship. Shattered in the ocean, it will make a sight for measuring sideways drift. The flask and drift indicator are seen below

OVERHAULING THE ENGINES

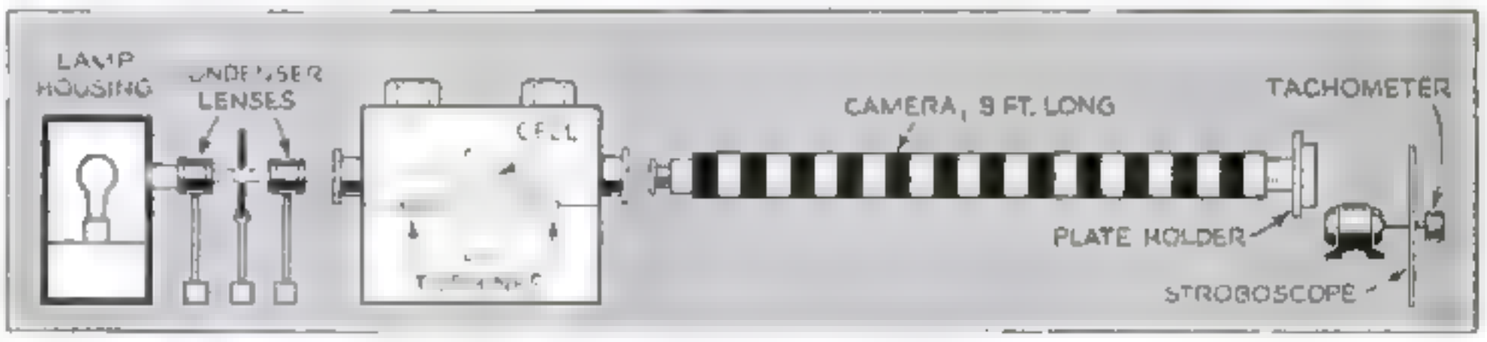
Mechanics at work on one of the 800-horsepower motors that drive the *China Clipper*. The inspection platform beside the motor housing folds back into the wing when not in use

Spinning Disk Measures Giant Molecules



Above, the nine-foot camera that photographs the substance under test Right, the rotor disk and cell with window

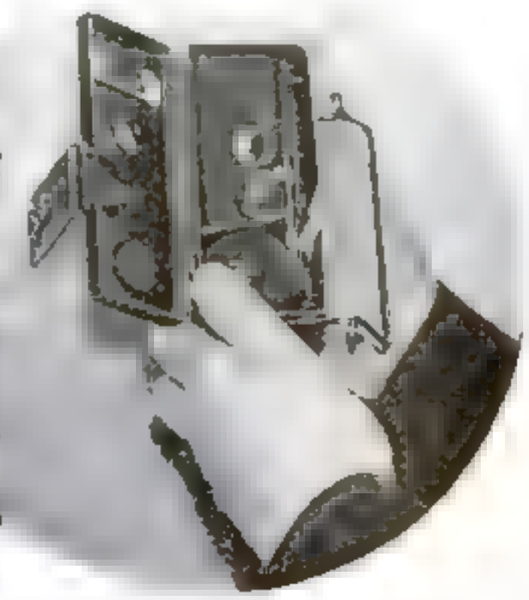
Experimenters lowering the shield of heavy armor which guards against the danger of the rotor breaking while its rim is traveling at rifle-bullet speed. Below, layout of apparatus



WHIRLING samples of chemical solutions at speeds up to 60,000 revolutions a minute, a remarkable machine just placed in service at the Du Pont Experimental Station at Wilmington, Del., makes it possible for scientists to measure the size of giant molecules. The heart of the device is a seven-inch metal disk in which a sample of the substance under test is placed, encased in a cell with transparent windows of quartz. Oil-driven turbines then set the disk spinning, requiring nearly an hour to bring it up to full speed. As in a cream separator, centrifugal force drives the heaviest components of the solution toward the outer end of the cell; and by observing the progress of the separation, which, by means of a light beam directed through the cell, is photographed at intervals with a nine-foot camera, scientists can estimate the size and weight of the molecules involved. A device called a stroboscope, a whirling slotted disk, is revolved in time with the flashes of light from the window of the rotor to gauge its speed. So great is the centrifugal force applied to specimens, attaining 250,000 times the force of gravity, that it would increase the weight of a 160-pound man to 20,000 tons! Known as an ultracentrifuge, the machine is of a type invented by T. Svedberg, Swedish chemist, who with similar apparatus has succeeded in weighing molecules of protein compounds.

CAMERA MAKES EIGHT MOVIES ON ONE FILM

By making eight successive rows of pictures upon a single strip of standard film, a pocket movie camera designed by a British actor approaches the ultimate in economy. As many as 144 of its midget views are packed in the space that five full-size frames would occupy. Mechanism within the camera automatically shifts the exposures from one row to the next without interrupting the picture-taking, and a similar mechanism is used in projection. The illustrations show the new camera and a sample of developed film.



The GUARDING INDUSTRIAL WORKERS AGAINST

RESPIRATORS THAT PASSED

These four types of masks were approved by the U. S Bureau of Mines dust laboratory for industrial use

IN AN amazing laboratory at Pittsburgh, Pa., a group of scientific sleuths are waging a never-ending war to protect American workers everywhere from the insidious and deadly menace of industrial dusts.

There, equipped with a microprojector, an amazing mechanical lung, and photo-electric eyes, Dr. Carlton E. Brown and his assistants at the U. S. Bureau of Mines Experiment Station look upon dust as a real public enemy. Like police dealing with a hardened criminal, they set elaborate traps for it and, when it is captured, put it through a rigorous "third degree." It is quizzed under the glare of blinding lights, made to stand in the "line-up" before a ruled screen so that it can be observed and measured, and—believe it or not—it is sometimes electrocuted!

Although the world's attention has been attracted lately to the silicosis cases among tunnel workers at Gauley Bridge, W. Va., this is but one outstanding instance of how dust can endanger life. In hundreds of factories, mines, shops, and other places where men work and live, constant guard must be kept against harmful dust, mist, and fumes.

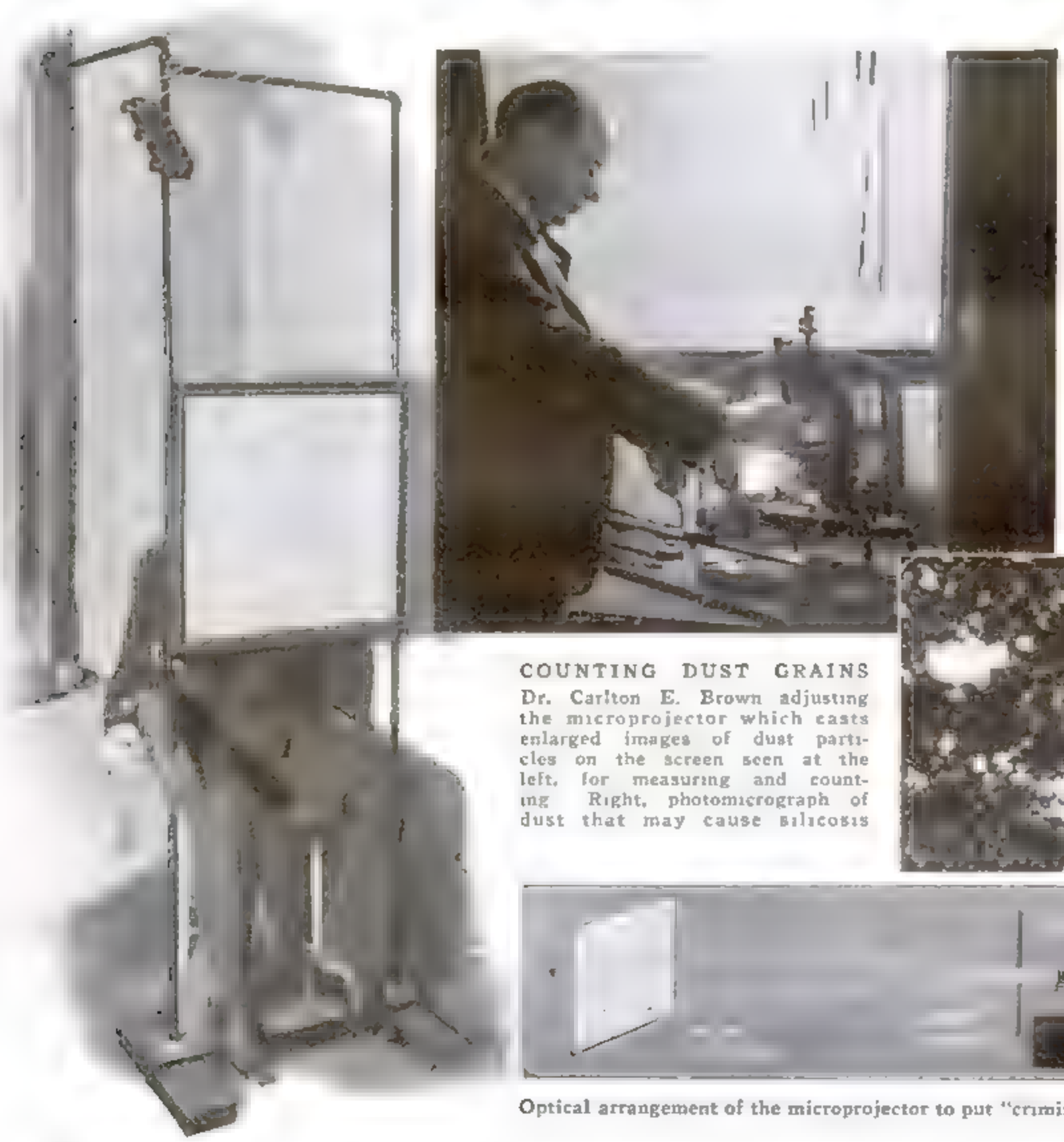
Suppose we go with Dr. Brown on one of his dust cases. An industrial concern has sent out an appeal for assistance in determining whether its workmen are being subjected to undue danger because of dust-laden air. The industry may be a mining company, and the particular place a copper mine; or it may be a manufacturing concern with a grinding department where dust is a nuisance if not an actual danger.

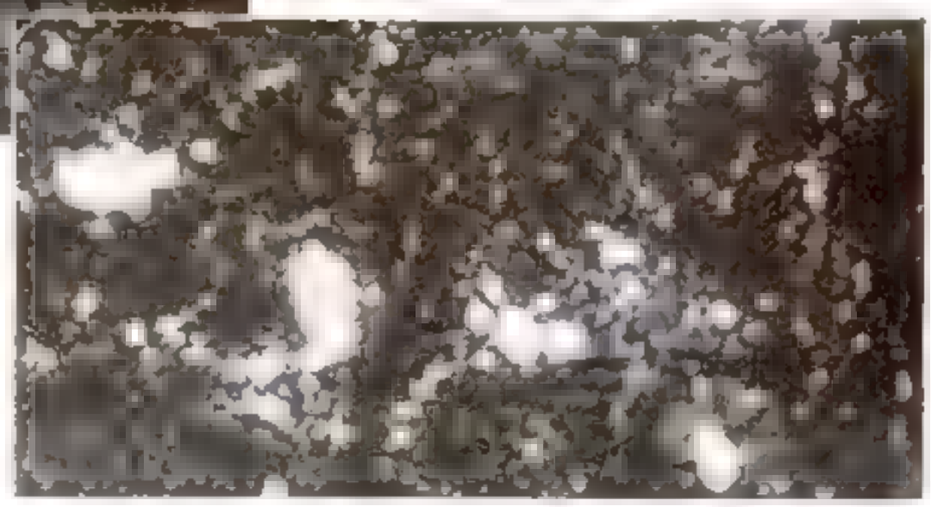
The chief weapon this dust sleuth uses during his visit to the scene of the suspected "crime" is a dust collector. One type frequently employed looks like a small hand pump and captures dust by forcing it against a glass microscope slide. The dust, usually slightly moist, adheres to the glass in a layer. The moisture soon evaporates, leaving the dry dust on the glass, the particles forming a narrow line.

Back to the laboratory Dr. Brown goes, with his evidence. Although, from a survey of plant conditions, he knows in a general way what kinds of dust specks he has captured, and their probable amounts, he must employ scientifically accurate methods of identifying and counting the dust particles before steps can be recommended for eliminating the hazard. What kind of dust is it? How big are the particles? How are they distributed as to size? These are some of the vitally important questions that must be answered.

There are a number of ways of identifying dust. In one, the dust samples are tested chemically to determine the materials present. Thus a sample may be tested for lead, arsenic, copper, silica, or other probable substances by standard chemical methods. Because of the tiny amounts of dust available, the extremely small-scale chemical reactions are often watched with the aid of a microscope

Another method of identification enlists the aid of a petrographical microscope—an instrument used in the study of minerals. Polarized light, which vibrates in only one plane, is directed on the dust particles. Because certain substances always look the same in polarized





COUNTING DUST GRAINS

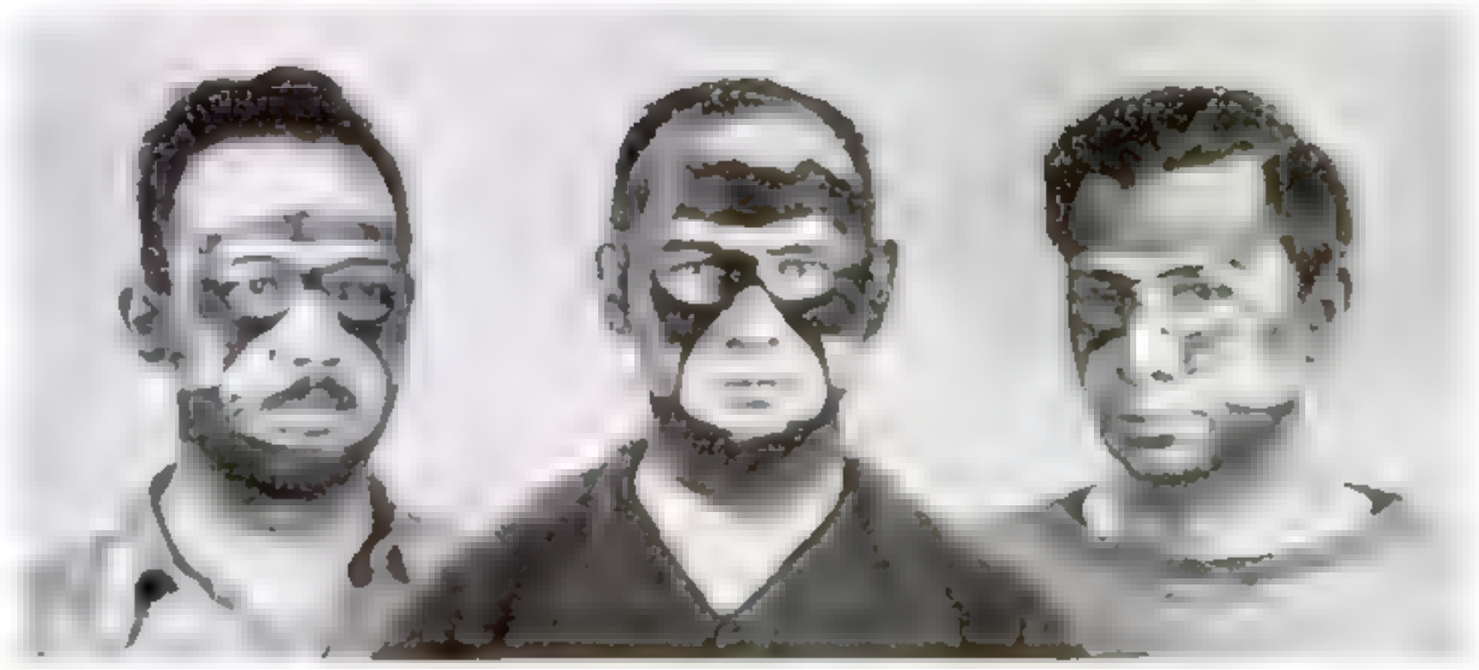
Dr. Carlton E. Brown adjusting the microprojector which casts enlarged images of dust particles on the screen seen at the left, for measuring and counting Right, photomicrograph of dust that may cause silicosis

Optical arrangement of the microprojector to put "criminal" dusts in the "line-up" on a ruled screen

Demon of Dust

light, no matter what the shape of the specimen, identification may be made. Another way is to measure the refractive index of the particles—their ability to bend light rays—by immersing them in various liquids whose refractive indices are known. When the liquid is found in which a given particle becomes invisible, its index is then known to be the same as that of the test liquid.

Two other ways of identifying dust are being put into use at the laboratory. One is to examine the dust with a spectroscope by measuring the wave length of the light given off by its white-hot vapor. The other is to study the molecular structure of the dust particles with X rays.



Not circus clowns, but Bureau of Mines men after wearing masks under test for leakage. Powdered coal dust was blown into their faces. Smudges show whether masks fit the faces snugly

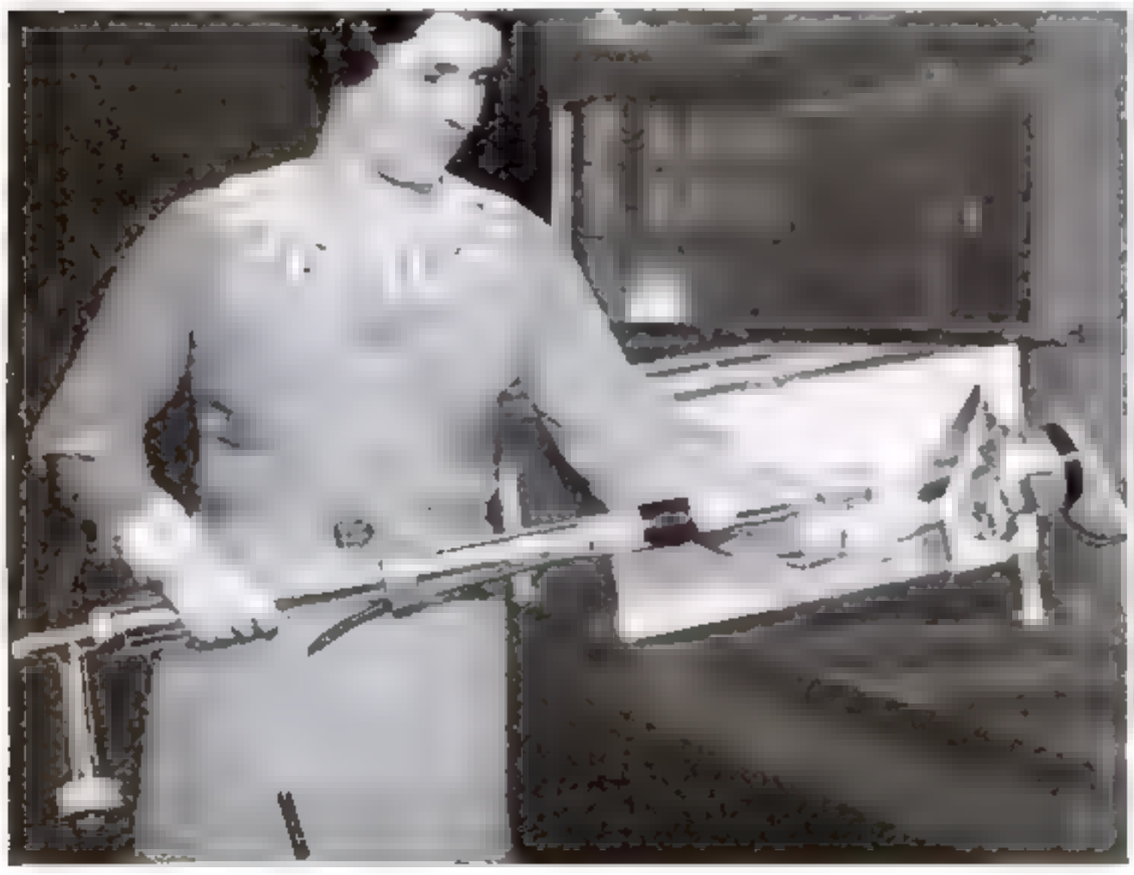
SETTLING the question of the size and number of the particles is done in a darkened room, with an ingenious microprojector devised by the Bureau of Mines. The usual way of measuring tiny specks of dust is too look at them through a microscope equipped to superimpose a measuring scale on the image. A piece of accurately ruled glass, known as a micrometer scale, usually is employed. It takes an expert about three hours of steady peering down the microscope tube to count and measure some 200 dust particles. And the work is fatiguing and hard on the eyes.

To speed up the counting process, and at the same time to make the job easier and less eye-tiring, the microprojector was arranged. In one corner of Dr. Brown's laboratory office is a booth made of composition board, with one side closed by a dark curtain. This contains the projector, which itself consists of an arc light, a water cell for cooling the light beam, and a microscope equipped with a projecting eyepiece and prism. Diagonally across the room, in another corner, is the screen. This is no ordinary piece of white cloth, but a square of lacquered tracing cloth carefully ruled so that it is divided into squares, some of them one centimeter on a side and others half that size. The screen is supported by an iron frame. Running from the frame to the microscope are three pairs of overhead wires supported by grooved wood pulleys. These wires are connected to grooved knobs on the microscope. Two pairs control the movements of the mechanical slide carrier, and the third the fine-adjustment focusing knob.

To count and measure the particles in a dust sample, the dust expert projects the image on the tracing-cloth screen, where it is seen at 10,000 times its actual linear size. By turning the control knobs at his side, he moves the overhead wires and focuses the microscope or moves the slide one way or the other. Size values and the number of *(Continued on page 126)*

Scientific Sleuths Give an Invisible Public Enemy the Third Degree with Odd Instruments

By WALTER E. BURTON



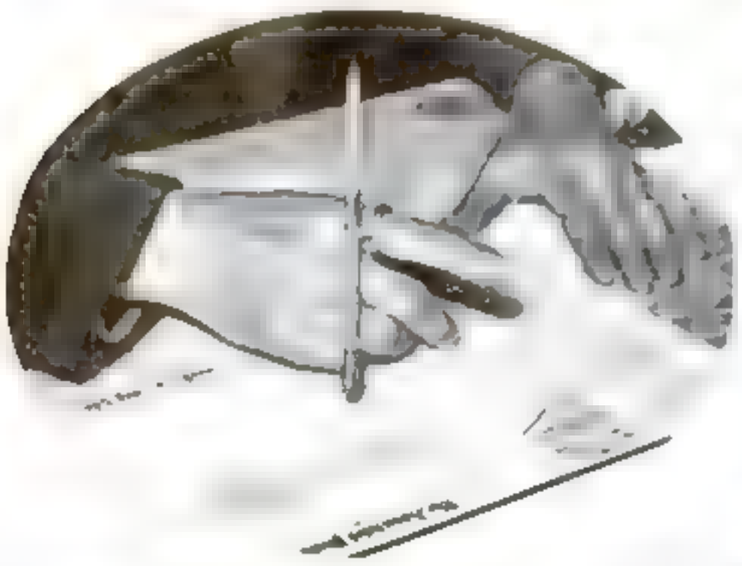
TESTING MASKS. This is part of the equipment used in generating a dust-laden atmosphere for testing respirators. At left, the "glass lung" is being attached to a filter to see what comes through

MURALS MAKE BEAVERS FEEL AT HOME

BEAVERS in a den at the Belle Isle Zoo, in Detroit, Mich., now cavort amid scenes resembling their natural habitat. To minimize the artificial appearance of the surroundings, an artist reproduced a colorful forest panorama, complete with pine trees, scrub brush, streams, and lakes, upon the concrete walls of the open beaver pit. Visitors are attracted by the novelty of viewing the animals against a woodland background.

FEET REPLACE CLUBS IN NEW VERSION OF GOLF

INVENTED by a physician to provide inexpensive outdoor recreation, a new game resembling golf, but played without clubs, is gaining popularity. Fourteen metal bowls, spaced from fifty to 500 yards apart, constitute "holes," and the object of the game is to kick a lively six-inch ball of white rubber into each bowl in turn in the fewest possible strokes. Kicks of 125 to 150 yards, counting the roll, are declared feasible on level turf.



PENCIL ON FINGER RING AIDS DESK WORKERS

TO KEEP a pencil handy and ready for instant use, an Oklahoma City, Okla., postal clerk has devised an ingenious holder. The pencil, thrust through a spring clip, is held by a ring encircling the index finger. A quick flip of the wrist swings it into position for writing, or out of the way upon the back of the hand, making it unnecessary to hunt for a mislaid pencil on a desk.

GEYSER FEEDS INDOOR SWIMMING POOL

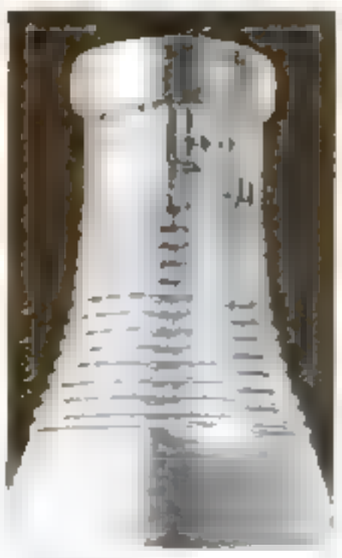
Rustic swimming pool in Yellowstone Park fed by geyser water. Special glass in the roof admits ultra-violet rays

A MOUNTAIN geyser, erupting every twelve minutes, provides a naturally heated water supply for a rustic indoor swimming pool just completed in Yellowstone National Park Wyo. When the geyser spurts up, the overflow is trapped in a catch basin and piped three quarters of a mile down the slope to the pool. The hot water is gradually air-cooled as it streams over gravel beds in a series of open concrete pits connecting sections of the pipe line. Ultra-violet rays of the sun penetrate the special glass roof of the pool to supplement the water's health-giving properties.

One of the open concrete pits that cool water as it flows through pipe line seen in drawing

MILK CAN'T RUN DOWN NECK OF NEW BOTTLE

HER husband's raids on the ice box for bedtime snacks inspired a Minneapolis, Minn., housewife to invent a milk bottle that will not leave wet rings on a clean table. Horizontal and vertical ridges on the neck of the container are said to stop any liquid trickling down the side of the bottle.

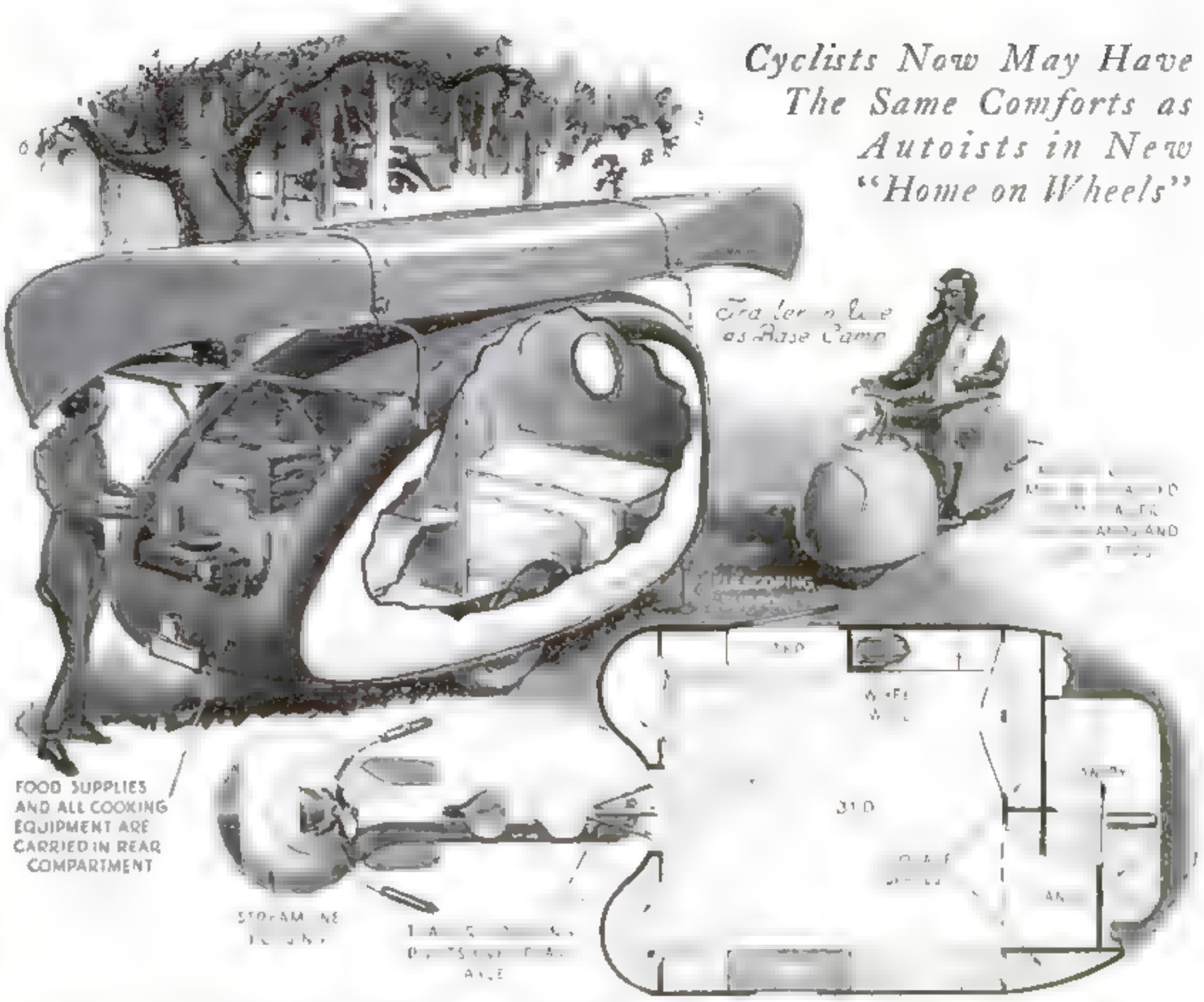


Ridges on the neck of this milk bottle stop fluid from trickling

Motor Cycle Pulls Trailer for Camping

Cyclists Now May Have The Same Comforts as Autoists in New "Home on Wheels"

SO THAT motor cyclists may enjoy touring comforts hitherto reserved to owners of cars equipped with trailers, a German inventor has evolved a junior-size home on wheels for camping and travel. In no sense a mere adaptation of existing auto-drawn units, the teardrop-shaped conveyance is designed from the ground up to suit the needs of the cycle enthusiast who would taste the pleasures of life along the open road. At the rear, a portion of the body swings upward to reveal a commodious pantry and a gasoline range for cooking. Brackets on the roof carry a canoe or kayak. A full-size double bed occupies the interior, which also is provided with closets and storage shelves. The trailer is towed by a detachable coupling that pivots above the rear axle of the motor cycle. While it can be used with any machine equipped with a suitable fitting, the inventor's design adds a motor cycle equipped with tandem seats and with sheathing styled to enhance the streamline contour of the composite vehicle as well as to obtain the full advantage of a complete streamline job.



Teardrop motor-cycle trailer detached for camping. The lower drawing shows how the space is apportioned

CHEMICAL PRESERVES WOOD AND FABRICS

Artisans applying new chemical preservative to woodwork. At right, a treated specimen unharmed by insects or rot after long service

A LIQUID preservative perfected by a Danish scientist for wood and fabric, consisting of a solution of organic salts of zinc and copper, has been successfully applied abroad and is now being introduced in this country. Odorless and clean to handle, the preparation may be applied with a brush or spray gun, or by dipping. Penetrating without the use of heat or pressure, the chemical impregnates the material with insoluble compounds that have the combined effect of fungicide and germicide. Building timbers and interior woodwork treated with the fluid, are said to be permanently safeguarded against the ravages of dry rot and insects. It also preserves canvas and fishing nets.

LAMPS GET COLOR FROM ULTRA-VIOLET RAYS

"FLUORESCENT lamps," declared fifty to 200 times as efficient as tinted incandescent bulbs, have been developed for decorative lighting effects. Ultra-violet rays, ordinarily wasted because they are invisible, are transformed into visible colored light by a chemical powder clinging to the inner glass wall of a tubular mercury-vapor lamp. Several of the lamps and the fluorescent powder are shown above.

SAILBOAT CAN'T SINK OR TURN OVER

The foolproof sailboat under full sail and, inset, floating on an even keel with decks awash

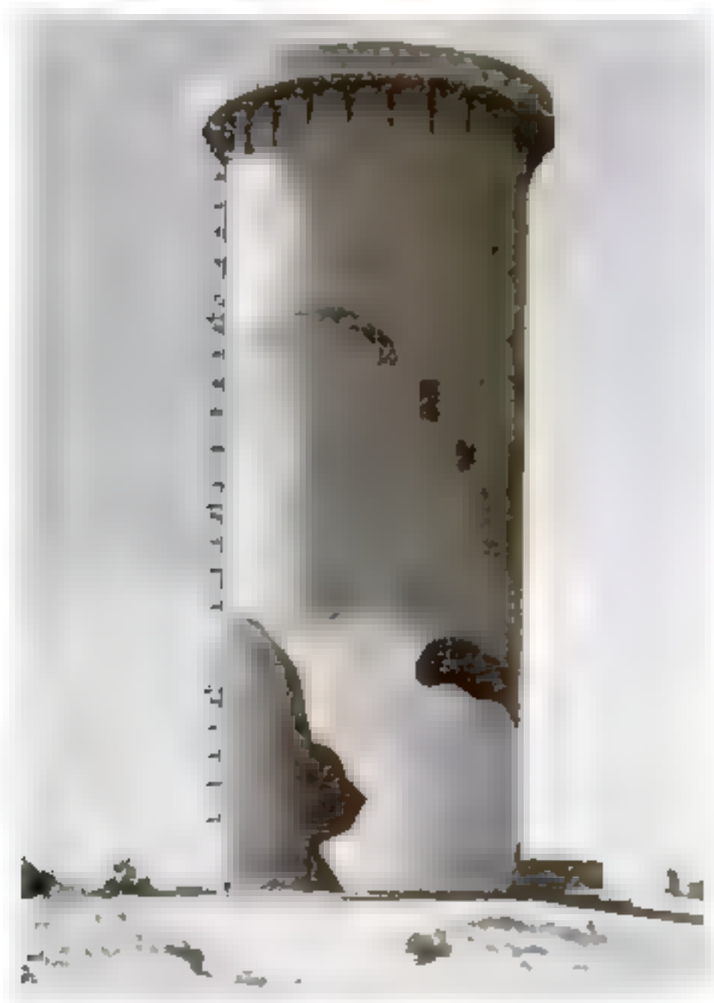
COMBINING speed with safety, a new racing sailboat designed by a California boat builder is declared unsinkable and noncapsizable. Air-tight compartments both fore and aft give the boat sufficient buoyancy to keep it afloat even though its decks are awash, while a 685-pound lead keel eliminates the danger of capsizing. In tests, the boat righted itself after being forcibly capsized, and stayed afloat until workmen could bail it out and sail it away. Only nineteen feet in length, the trim craft carries 187 square feet of sail when fully rigged. It is said to handle easily and to match the performance in many respects of large seagoing sailing yachts.

LINEMAN'S GLOVES ARE GROUNDED

ELECTRICAL installers and repair men are protected from high-voltage currents by wired safety gloves recently invented. Made of insulating rubber, each glove is honeycombed with a network of fine wire mesh, which is grounded through a terminal embedded in the gauntlet. When used by linemen working on poles and towers, the gloves are connected to a similarly wired safety belt; the latter is then grounded. Whenever electric current accidentally flows through the glove wiring, the wires heat up and warn of danger.

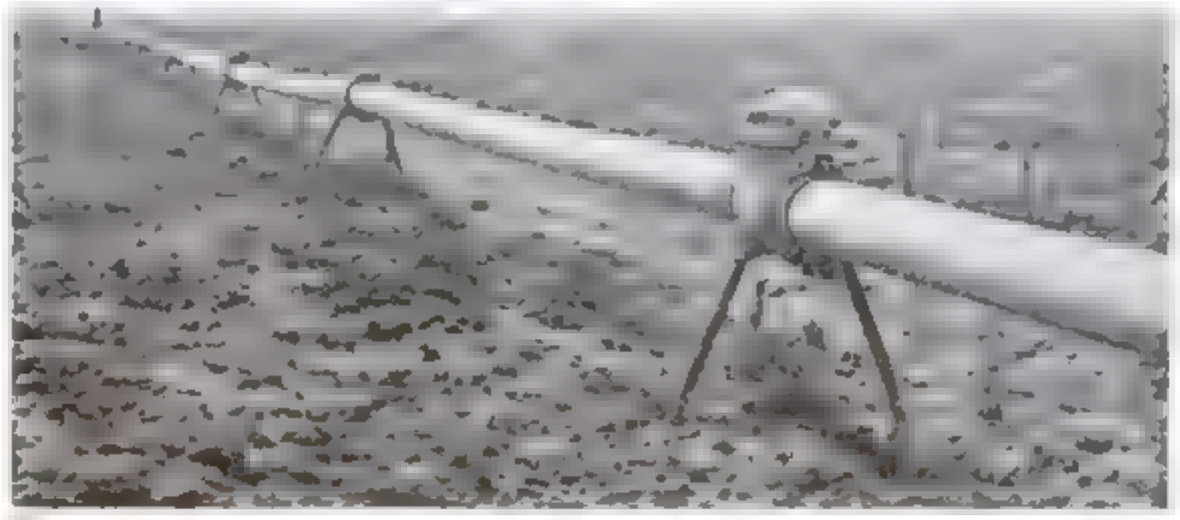
CAMOUFLAGE CONCEALS UNSIGHTLY WATER TANK

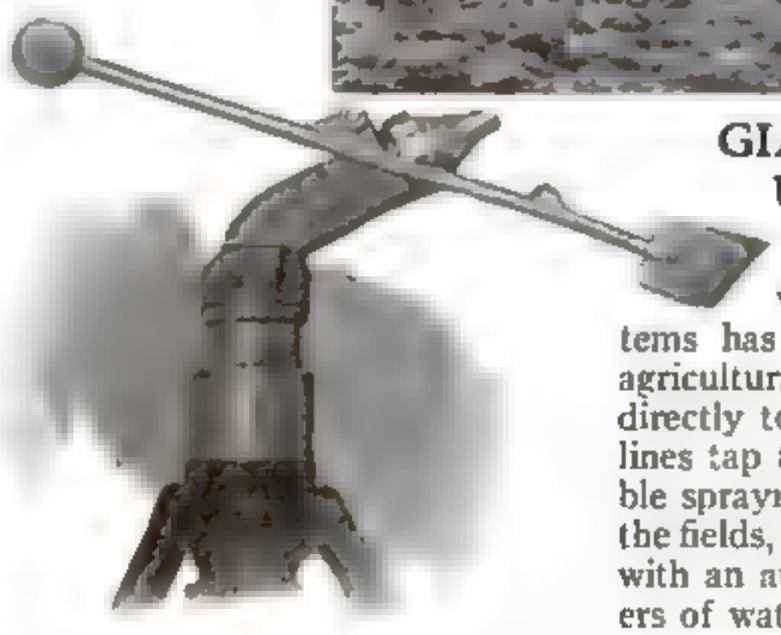
MEMBERS of the famous art colony at Provincetown on Cape Cod, Mass., recently redecorated a local water standpipe so that it no longer constituted an eyesore to the community. Following a carefully planned camouflage scheme, the black water tank was repainted a light blue and then skillfully covered with a patchwork of other colors.



This standpipe at Provincetown, Mass., was an eyesore till artists "erased" it by camouflage

An irrigation pipe line in a Russian grain field, with spraying carts in action. Below, one of the swinging nozzles that cast water on the soil





GIANT IRRIGATION SYSTEM USES MOBILE SPRAYERS

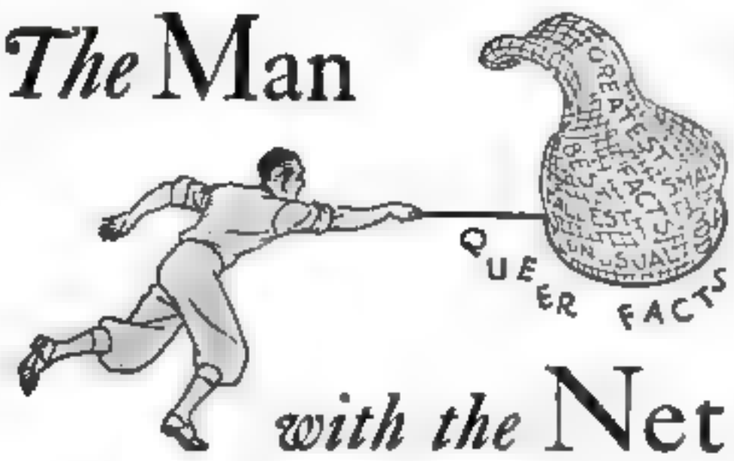
A MAMMOTH "rain-making" project which dwarfs conventional irrigation systems has recently been completed in a Russian agricultural district. Reservoir water is pumped directly to a grain-field pipe line, and flexible hose lines tap this field supply and feed water to portable spraying carts. As the carts are drawn through the fields, powerful "rocking-chair" nozzles, equipped with an automatic swinging mechanism, rain showers of water over a wide area.

NEW SAFETY GLASS BENDS LIKE RUBBER

GLASS that bends like rubber when it is broken is the latest development in safety material for automobile windshields, airplane cockpit covers, and other purposes where shattered glass is a menace. Like other forms of safety glass, it is made by sandwiching a plastic substance between two layers of ordinary glass, and the synthetic resin used for this purpose gives the new glass its flexible character. When broken, it can be stretched or even rolled up like a rug.

Broken safety glass bent to show how it holds together

The Man *with the* Net



COLLECTING *safety razor blades is the novel hobby of an Oklahoma City man.*

DEATHS *from asphyxia occur twice as frequently as those caused by automobile accidents.*

SNAKES *hear with their tongues, the tips of which are highly sensitive to even slight sound vibrations.*

IN WRITING *Ethiopian script, a colon is placed at the end of each word.*

AN AVERAGE *of 5,000 watches are pawned daily in New York City.*

A SPARROW'S SHORT NECK *has twice as many vertebrae as that of a giraffe.*

CARCASSES *of whales sometimes ignite spontaneously due to the union of fats with the oxygen in the air.*

AN ACRE *of good corn, during its growth, gives off 3,000 tons of water.*

PERSONS *who live to be seventy spend an average of twenty-three years sleeping, thirteen years talking, and six years eating.*

COCONUT TREES, *during hurricanes, may bend until the tops touch the ground without breaking.*

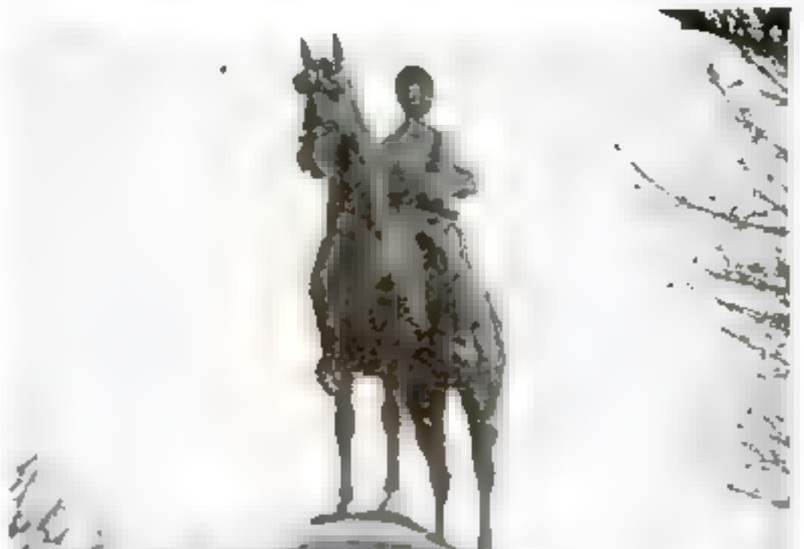
CONSTANTIN *is the name of an alloy, whose electrical resistance remains almost constant regardless of temperature changes.*

THE DISTANCE *between Europe and America varies as much as sixty-three feet in a year. Lunar tides in the solid earth cause this land movement.*

THE PARIS *(France) Police Department keeps a force of trained rat-catching cats. They may be hired for a small fee.*

STATUE "TRIED OUT" IN WOODEN COPY

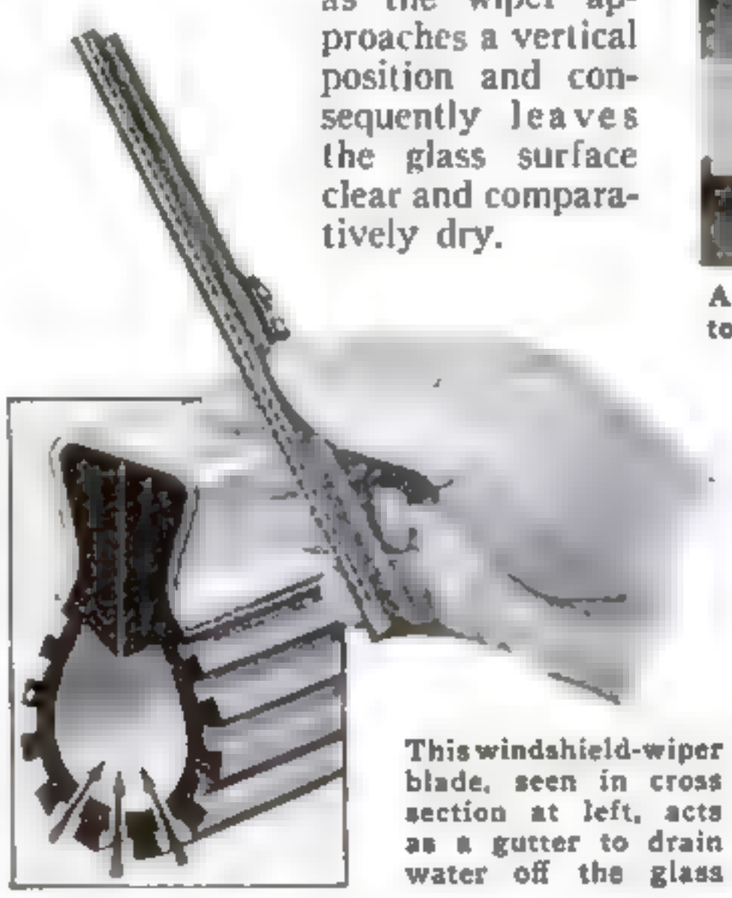
To SHOW how a statue would look in a proposed setting in a Paris park, French architects recently set up a full-sized wooden model. The unusual procedure gave the public a chance to pass on the merits of a projected $75,000 memorial to the late King Albert of Belgium and was calculated to forestall any possible criticism of the design or the placing of the permanent statue. The effigy in wood was carefully carved by the same sculptor, Armand Martial, who is creating the figure in bronze. Viewed at a distance, the model appeared strikingly like metal.



A wooden replica of a statue, erected in a Paris park to show how the proposed work in bronze will appear

HOLLOW WIPER DRAINS RAIN OFF WINDSHIELD

A WINDSHIELD wiper recently marketed employs a hollow rubber blade that drains off rain water as it wipes the glass. When the blade moves back and forth, flexible wiping ribs create a suction effect that draws the water into the tubular body of the device through rows of perforations. The water drains out of the lower end as the wiper approaches a vertical position and consequently leaves the glass surface clear and comparatively dry.



This windshield-wiper blade, seen in cross section at left, acts as a gutter to drain water off the glass

PRISMS AID BED READER

TO MAKE reading in bed easier, a British inventor has devised "lying-down" spectacles. Prisms mounted in eyeglass frames bend the light rays at right angles so that the wearer can lie flat and read a book held upright on his chest.

ENDLESS LADDER GIVES EXERCISE TO CLIMBER

CLIMBING, pushing, pulling, lifting, and other forms of exercise are provided by a vertical treadmill designed by an Oregon inventor. Two endless chains, running over sprocket wheels, are joined by steps to form a rotary ladder. An adjustable brake regulates the needed motive force.

Endless-chain exercising machine in use. A brake regulates the force required to move it

Wonders of SEA SHELLS

Examination Reveals How Nature Fashions Beautiful

OF THE many reasons why adventuring with the microscope can be such a fascinating hobby, not the least is the fact that it lends new and unsuspected interest to apparently simple, commonplace objects. Consider, for example, that bit of sea shell on your work table.

The shell was produced as half of the outer covering of a bivalve, a mollusk related to the oyster and similar marine animals. Examine it closely with your unaided eyes. The outer surface of this particular specimen is, perhaps, a mixture of colors—black, brown, and a grayish white; and it is broken up into steps, roughly parallel. Turn the shell over, and you find that the concave side glows with an iridescent, pearly luster. Colors of the rainbow play over it. This is mother-of-pearl, or nacre.

A simple thing, this shell. Yet, to produce all those colors and that iridescence must require some hidden mechanism, or at least something not visible to the naked eye. It is time to turn to your microscope. Here begins a new series of thrills; for, in order to find out all you can about that shell, you will have to perform numerous interesting operations on it—operations, by the way, which are applicable to the preparation and study of a great many other things of interest to the amateur microscopist.

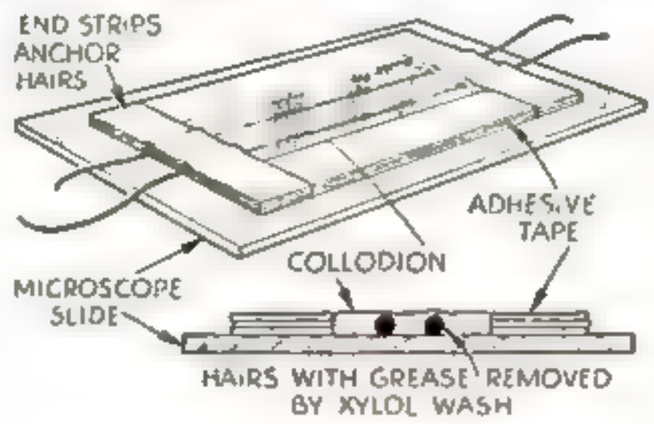
First, as with all things, this particular shell is to be given a general examination at moderate powers, say at fifty or seventy-five diameters. Hold the shell up to the light. It is so thick that it is only slightly translucent, for the most part. But near the edge, are several spots which are almost transparent. Lay the shell on a clean glass slide, move it until one of the nearly transparent spots is beneath the lens, and focus carefully.

Surprise No. 1! The shell is not the homogeneous, uniform structure you thought it was. Seen at seventy-five times its original size, it becomes a miniature mosaic of colored stones, fitted together with a perfection that is little short of uncanny. It reminds you of a tiled pavement. Most of the little blocks have six sides, although there are some with only four, and others with more. But how beautifully they are fitted together!

Now turn the shell over so that its pearly side is uppermost. Again focus near the edge, over one of the nearly transparent spots where the pearly luster seems to be lacking. Again you see that wonderful mosaic, only, perhaps, smoother and more perfect; for you noticed that, on the outer surface, some of the little "stones" had a scaly appearance. These on the pearly side, however, are perfectly smooth.

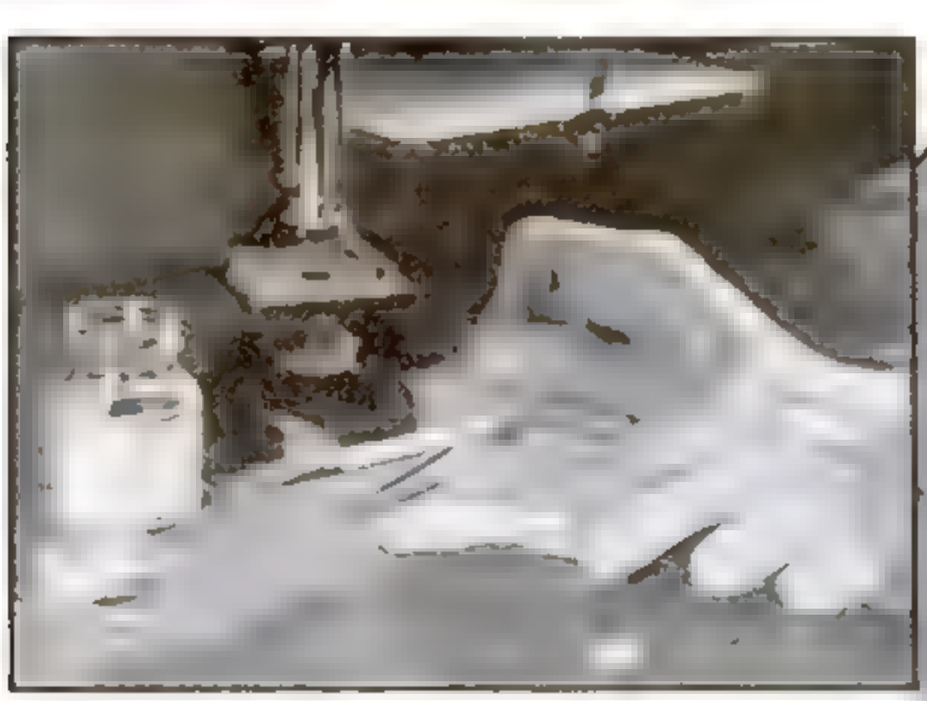
Now move the slide sideways, until the point of focus moves toward the center of the shell. The appearance of the surface, as you refocus your lens, changes abruptly. Now, instead of the cobblestone pavement, you are gazing at something that remotely resembles the surface of a piece of wood with prominent grain. There are scores of fine lines, curving and circling about, each managing somehow to be almost parallel to its neighbor on either side. At a higher magnification, and with careful manipulation of the light (which must be incident, not transmitted), you discover that these gracefully sweeping lines are themselves kinked and wavy. Thus you find that mother-of-pearl—for that is what you are examining—is marked by characteristic wavy lines which, somehow, have much to do with the iridescent appearance of the material

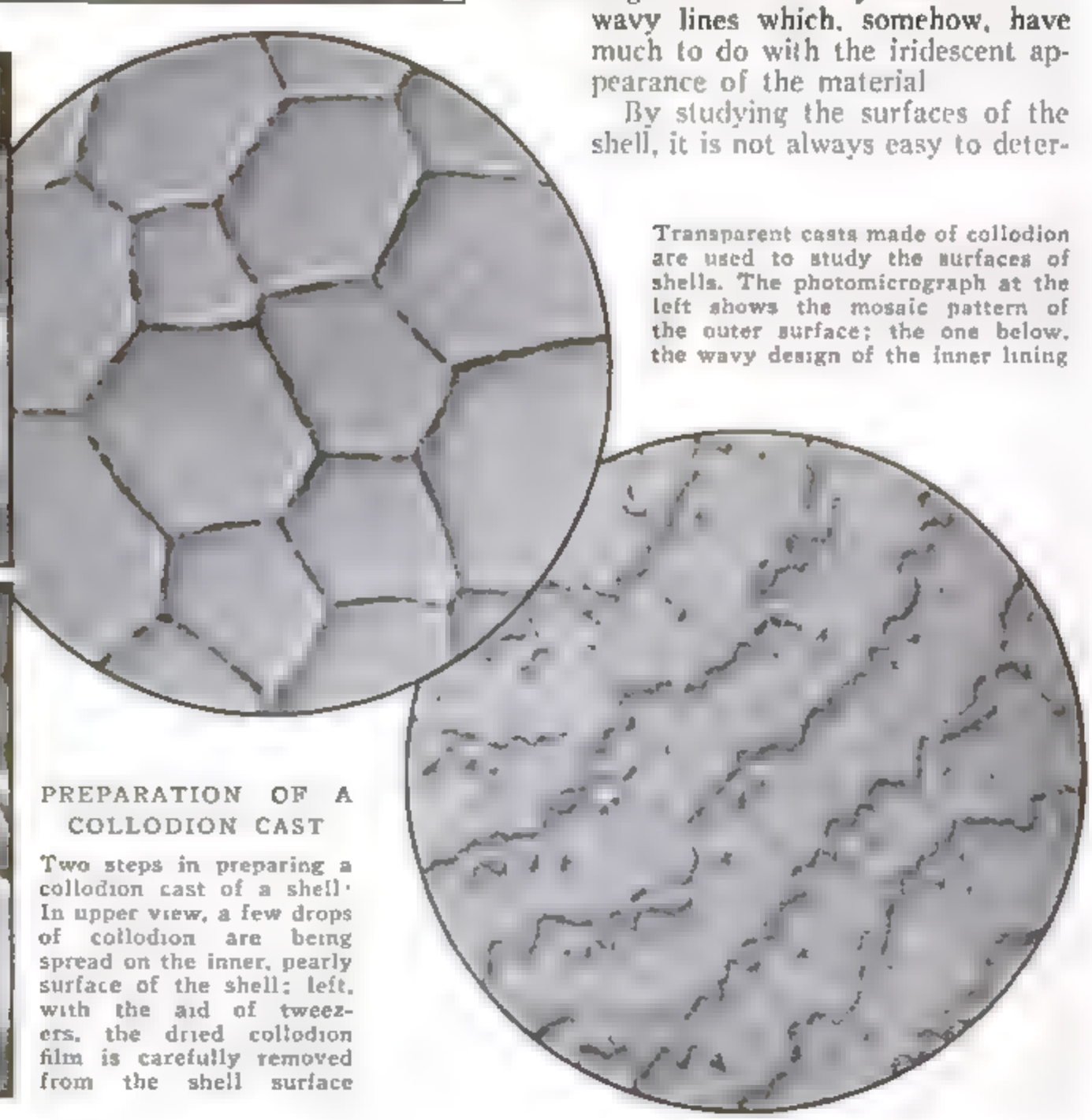
By studying the surfaces of the shell, it is not always easy to deter-



Studying Human Hairs With Collodion Casts

The surface markings of human hairs are easily studied by means of collodion casts. To make such a cast, wash the hairs in a solvent like xylol to remove grease. Next, place them on a glass slide, fastening the ends with strips of adhesive tape, and build up a rectangular wall around them with other pieces of tape. Into this well the collodion is poured. When it has set firmly, peel the cast from the slide and pull the hairs from the collodion bed. The cast is then mounted in the customary manner for microscopic work.





Transparent casts made of collodion are used to study the surfaces of shells. The photomicrograph at the left shows the mosaic pattern of the outer surface; the one below, the wavy design of the inner lining

PREPARATION OF A COLLODION CAST

Two steps in preparing a collodion cast of a shell. In upper view, a few drops of collodion are being spread on the inner, pearly surface of the shell; left, with the aid of tweezers, the dried collodion film is carefully removed from the shell surface

Shown by Your Microscope

Coverings for Common Mollusks

By MORTON C. WALLING

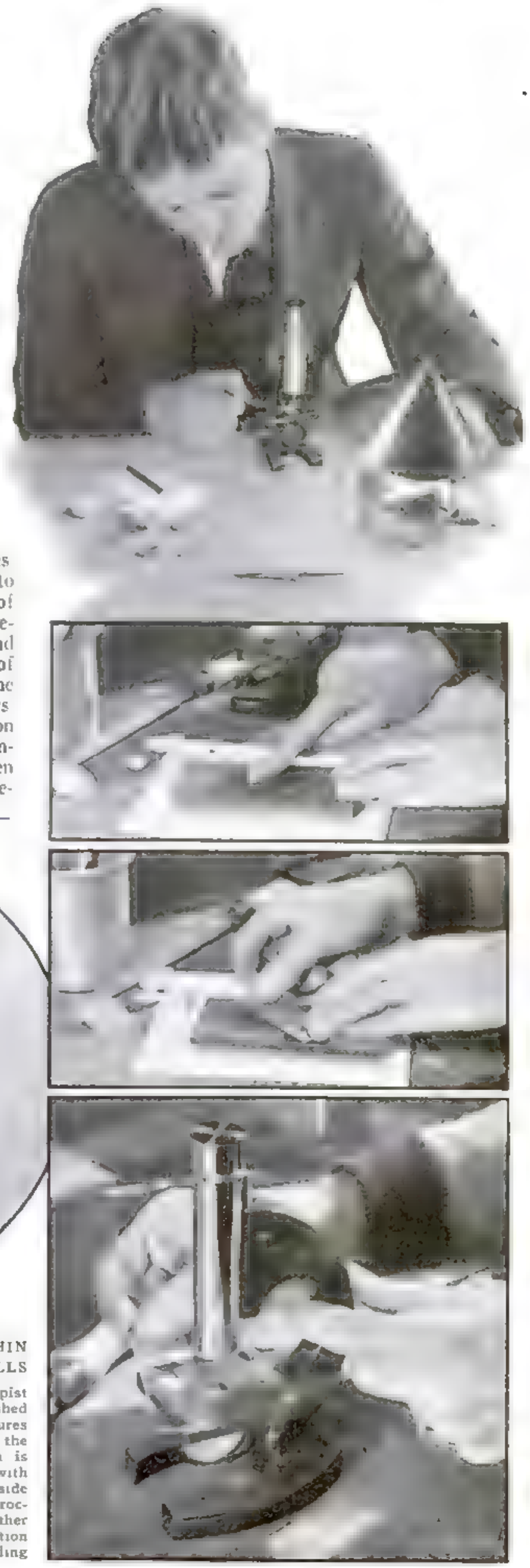
mine exactly whether some of the markings are ridges or grooves or other irregularities, or whether they are merely the result of pigmentation. There is an easy and striking way of finding out. It is, incidentally, a little trick that can be used for revealing hidden details in a great many other objects.

Go to the drug store and get an ounce of flexible collodion. This is a solution of guncotton or pyroxylin in ether and alcohol, and consequently is very inflammable and even explosive under certain conditions. So, in handling the bottle, use the same precautions you would with so much gasoline or pure ether. *Keep flame away from it.* Instead of collodion, a solution of celluloid in acetone can be used.

With a toothpick, place two or three drops of collodion on the inner, pearly surface of the shell, and spread it out in a thin layer that extends to one of the thinnest edges. In a few minutes, the hardened film will be dry enough to permit peeling. Raise one edge with a needle or sharp knife blade, and grasp it with tweezers. Pull gently and evenly, and the film will come off in a single piece, or at least in a piece large enough for observation. Be sure that you peel off some near the shell edge. Transfer the film to a clean microscope slide, laying uppermost the side that was in contact with the shell. In a similar way, make a collodion cast of the outer surface of the shell

Examination at 100 or so diameters reveals that you have captured considerable beauty in those simple pieces of pyroxylin. There is the mosaic pavement near one edge of the first film. The individual blocks are smooth and even. Now look at that from the outer surface, and you find that the blocks are not so smooth, but are roughened in spots, where the shell has encountered sharp stones and the like. The cast of the pearly surface resolves itself into a series of wavy lines very much like those you saw on direct inspection. You still can see the iridescent colors by tipping the film to various angles while looking at it with your naked eyes This little experiment seems to indicate that the iridescence of mother-of-pearl is largely a result of surface ridges and grooves, which, because of their fineness, break up the light rays into prismatic colors

This making of collodion casts is a stunt worth remembering. You can use it often in microscopy, for revealing details *(Continued on page 111*



The magnified shell section at right was ground and polished on a hone. Below, cell structures after removal of lime by a weak acid. Note the irregularity of the cell formations

HOW TO MAKE THIN SECTIONS OF SHELLS

Top view, the microscopist ready to examine a polished shell. The lower pictures show stages in preparing the shell. First, the section is ground on a hone. Then, with the ground and polished side cemented to a slide, the process is repeated on the other side. Frequent examination will prevent overgrinding

New Tools FOR *Gardeners*

SILENT LAWN MOWER. Its pneumatic tires, special gear drive, and very light weight make this mower easy to operate as well as silent. It can be used in the early morning hours without fear of disturbing the slumber of neighbors

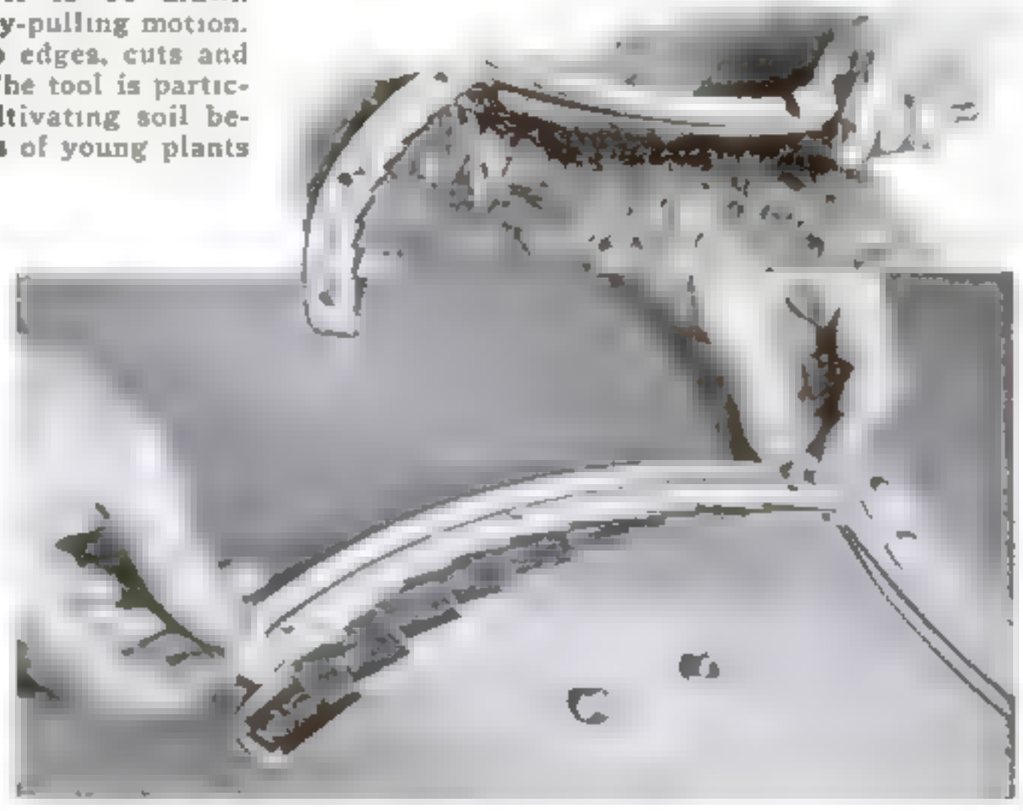
TWO-IN-ONE LAWN EDGER. This odd-looking edger not only trims grass along pavements, but also digs a trench. If the handle is lowered, the circular cutter at inner side of the implement cuts the trench. With the handle held up in normal position, the outer wheel drives the self-sharpening, rotary grass trimmer

COMBINATION HOSE NOZZLE. Equipped with a reversible jet attachment and a convenient hand valve, a useful nozzle for the garden hose delivers a fine, harmless spray for sprinkling plants and flowers, a narrow, forceful stream for washing walks, or the full stream necessary for watering the lawn

OPEN-FACED HOE. This skeleton hoe cultivates and weeds with one operation. Its open-face design permits it to be drawn through the soil with an easy-pulling motion. The pointed tip, with sharp edges, cuts and uproots all weed growths. The tool is particularly well adapted for cultivating soil between closely arranged rows of young plants

ONE-AT-A-TIME SEEDER. It is an easy matter to sow seeds one at a time with the hand seeder illustrated. An adjustable gate aperture adapts the device for use with seeds of varying sizes—ranging from relatively small ones to those as big as sweet-pea seeds

SOIL-TESTING KIT. With the compact, easy-to-use testing kit shown below, any home gardener can analyze his soil for its content of essential plant foods, such as nitrogen, potash, and phosphorus, as well as for its degree of acidity. With this valuable information at hand, he can supply his garden with the proper fertilizer and will know the type of plants that grow best in his soil



RAZOR-EDGE SICKLE The cutting edge of the sickle seen at the right is supplied by nine razor blades. One member of the holder frame is removable to permit the insertion of the blades which are held in place in steplike fashion. A protecting guard swings up and is fastened to the handle when the sickle is in use as shown in the upper photograph

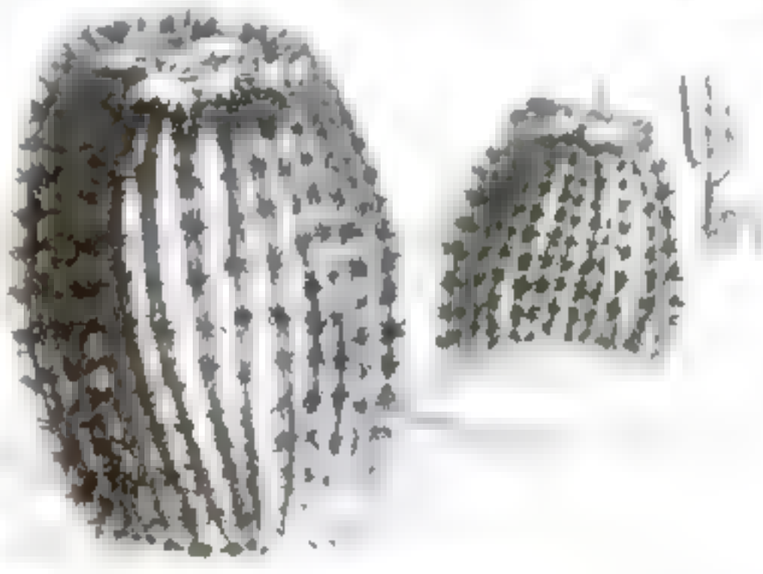
Un-Natural History

By GUS MAGER

CORN (OR INDIAN CORN, TO USE ITS CORRECT NAME) CANNOT SURVIVE WITHOUT THE AID OF MAN! ITS SEEDS, OR KERNELS, HAVE NO NATURAL WAY OF DISTRIBUTING THEMSELVES. UNKNOWN IN EUROPE BEFORE THE DISCOVERY OF AMERICA, IT WAS FOUND UNDER CULTIVATION BY THE INDIANS. NO WILD CORN, OR ANY RELATED PLANT, IS FOUND ANYWHERE IN THE WORLD, AND SCIENTISTS CANNOT EXPLAIN WHERE IT CAME FROM

AND HERES A FISH WITH A GUN! THE BEAKED CHAETODONT, A NATIVE OF THE SOUTH SEAS, USES ITS ELONGATED SCHNOZZLE TO SHOOT A DROP OF WATER AT THE LAND INSECT IT STALKS FOR ITS PREY. THE BUG DROPS INTO THE WATER AND IS EASILY COLLECTED FOR DINNER

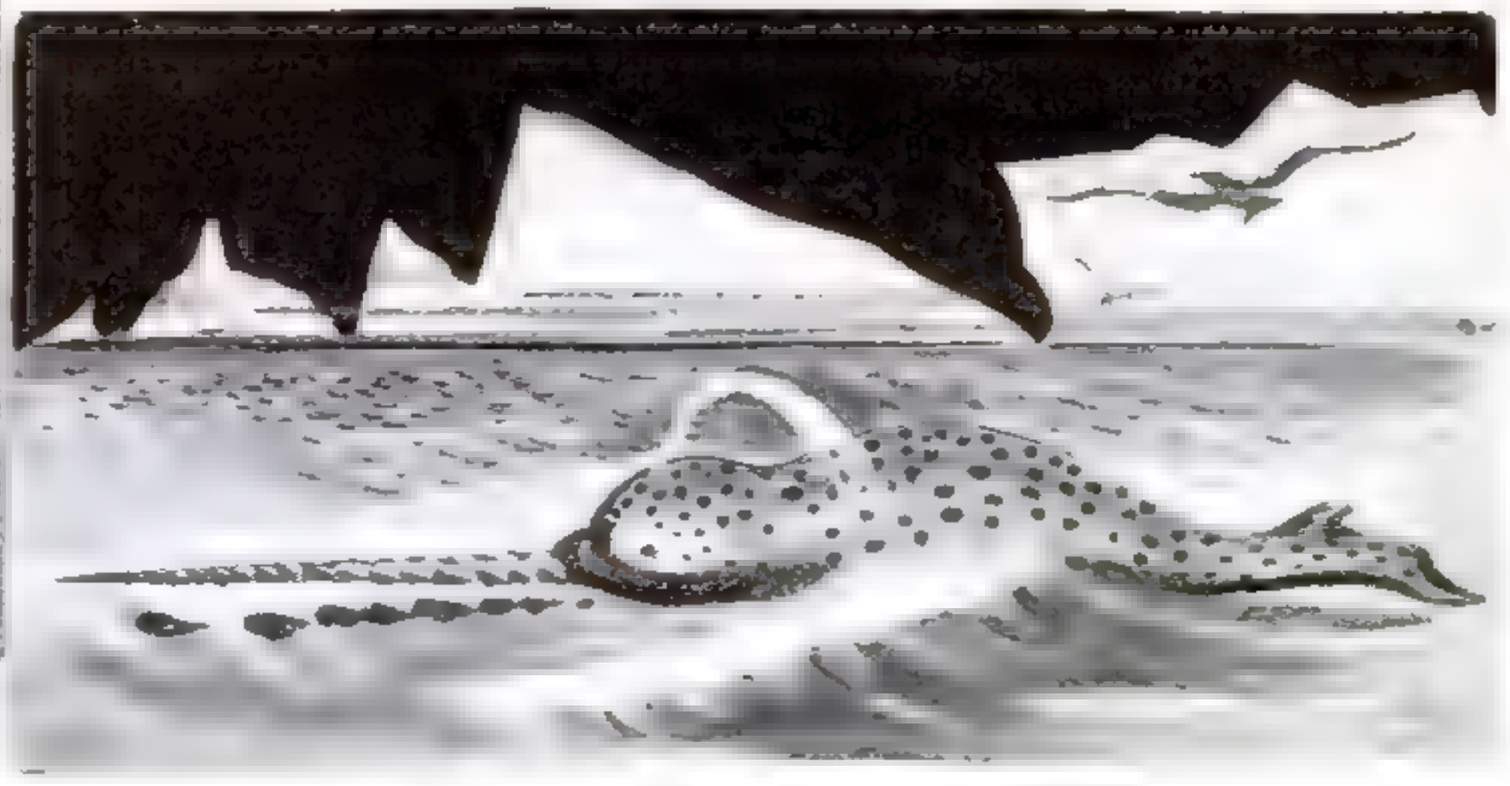
YOU CAN CONFIDE YOUR SECRETS TO A GIRAFFE. THIS DISCREET ANIMAL IS COMPLETELY MUTE AND NEVER UTTERS A SOUND, IT IS SAID



THE BARREL CACTUS OF ARIZONA IS THE CAMEL OF THE PLANT WORLD. SHAPED LIKE A BIG KEG, IT SOAKS UP ENOUGH WATER FROM A RAIN TO LAST IT FOR MONTHS OR YEARS — SAVING FOR LOTS OF UNRAINY DAYS!

TOO BAD A DUEL CAN'T BE ARRANGED BETWEEN THE BOMBARDIER BEETLE AND THE GUN-TOTING FISH SHOWN ELSEWHERE ON THIS PAGE. THIS INSECT SHOOTS A FINE SPRAY OF DEFENSIVE FLUID FROM A SAC AT THE END OF HIS ABDOMEN. ONE KIND HAS A REPEATER!

THE LONG, SPIRAL TUSK OF THE MALE NARWHAL IS OFF CENTER, GROWING OUT OF THE LEFT SIDE OF THE CREATURE'S UPPER JAW. IT IS ONE OF A PAIR OF FRONT TEETH, BUT THE RIGHT-HAND ONE NEVER DEVELOPS!



Latest Inventions FOR THE HOUSEHOLD

WASHING MACHINE CHARGES BATTERY

Gasoline-powered washing machines, used on farms and estates not served by power lines, now can be fitted with a small generator unit to charge storage batteries for tractors, automobiles, or radios. Mounted on the platform with the engine, the generator is hooked up to the pulley by means of a drive belt

ADJUSTABLE CLOSET ROD. Suspended from garment hooks on the opposite walls of a closet, the telescoping rod illustrated above furnishes a highly adaptable support for clothes hangers. It cannot slip off the hooks

SPOON GRIPS FOOD

When the spring handle of this serving spoon is squeezed, the tonglike frame opens. Released, it grips the food and keeps it from slipping

BOTTLE OPENER HAS SEALING CAP

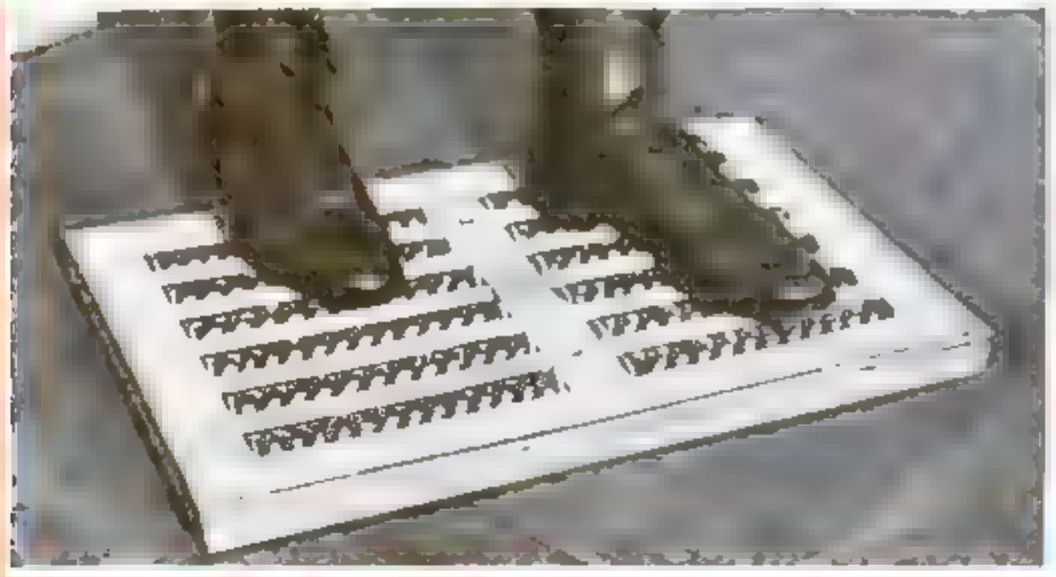
To preserve the freshness of beverages after the bottles are opened, a new cap lifter contains a rubber sealing plug which can be clamped over the bottle lip. It gives an air-tight seal on all standard necks, and cannot be blown off easily

BRIDGE SCORE IN HANDY ROLL

Clipped to the edge of a bridge table, the attachment shown above holds score sheets for 200 rubbers in a continuous roll. It keeps playing surface clear and score always handy

DOOR MAT USES ROTARY BRUSHES

Looking like a carpet sweeper turned upside down, the door mat pictured below is fitted with a dozen rotary brushes set in recesses. Turned by scraping the feet, they are said to make an unusually good job of removing mud from the shoes



STRETCHER FOR DOILIES. The difficulty of laundering doilies without spoiling their shape is met by this stretcher. An entire set of the same size and shape can be done at once

TRANSPARENT COVERS FOR STACKS OF PLATES

Dust cannot soil stacked plates when they are protected by these handy covers. Made of a transparent material reenforced by a coarse fabric mesh, they are bound in colored tape to match china patterns. The covers are available in seven sizes, of various diameters and heights

FISH BOWL IN BASE OF LAMP

Something new in aquariums is a novel table lamp which has a bowl for tropical fish as its base. An auxiliary bulb in the upper part of the base keeps the water at the proper temperature for the fish. The shade is appropriately decorated with tropical scenes to act off the unusual ornament

CARRYING HANDLE FOR MILK BOTTLES

For use in carrying milk bottles home from dairies or grocery stores, a metal carrier locks around the bottle neck and provides a wire bail for the fingers. It is shown above being attached to a bottle and, at right, in use

FOLDING CLOTHES DRYER

An indoor clothes dryer that can be folded up like an umbrella is a new convenience for the housewife. It can be set up in a moment in the kitchen, before a radiator, or in the bathtub for dripping

FOUR-IN-ONE KITCHEN CUTTER

Shredding, slicing, grating, and mincing can all be done on a single kitchen cutting device recently marketed. Various blade arrangements are used in different ways to accomplish the many kinds of cutting possible. The makers claim that this one compact tool, conveniently handled and stored, will do the work of many cutting accessories

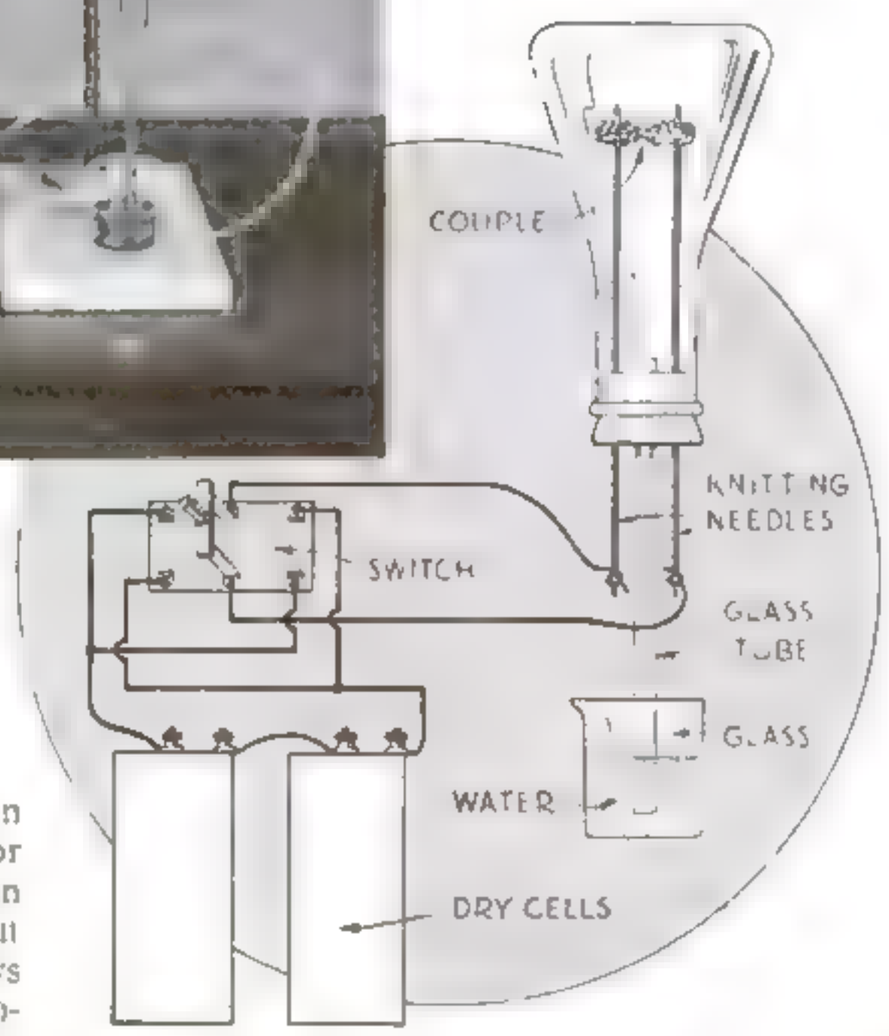
Three Magic Metals

Producing Cold With Electricity and A "Quicksilver Heart" That Beats Are Only Two of the Amazing Tests You Can Perform Easily With Simple Substances

By Raymond B. Wailes

HEAT OR COLD FROM ELECTRICITY

When a current of electricity is passed through a joint of antimony and bismuth, as illustrated, a heating or cooling effect is produced, depending on the direction of the flow. Apparatus is shown in drawing at right



YOU are accustomed to seeing an electric element in a toaster or radiant heater grow red-hot when current passes through it—but did you know that when electricity flows through joints of certain metals, it produces a *cooling* effect? Have you ever made a drop of murcury behave as if it were alive or prepared a pair of magical allovs that are solids when separate, and a liquid when mixed?

These are a few of the fascinating experiments that you can perform with metals, using three in particular that you may not have employed before in your home laboratory—mercury, antimony, and bismuth.

You may already have discovered that many of the metals needed in your experiments can be found in your home. They should be prized, bottled, and labeled like any other chemicals. The shell of an old dry cell will furnish you with zinc, and worn-out pots and pans with aluminum while the mesh scrapers used to clean them supply copper in handy form. Likewise, mercury, which is expensive to buy, may be available right at hand. It can be salvaged from a broken or discarded thermometer, provided, of course, the instrument is not one of the kind that uses alcohol colored with a dye. The quantity of mercury will be small, but it will be ample for a number of tests, and it is easy to clean and use over and over again.

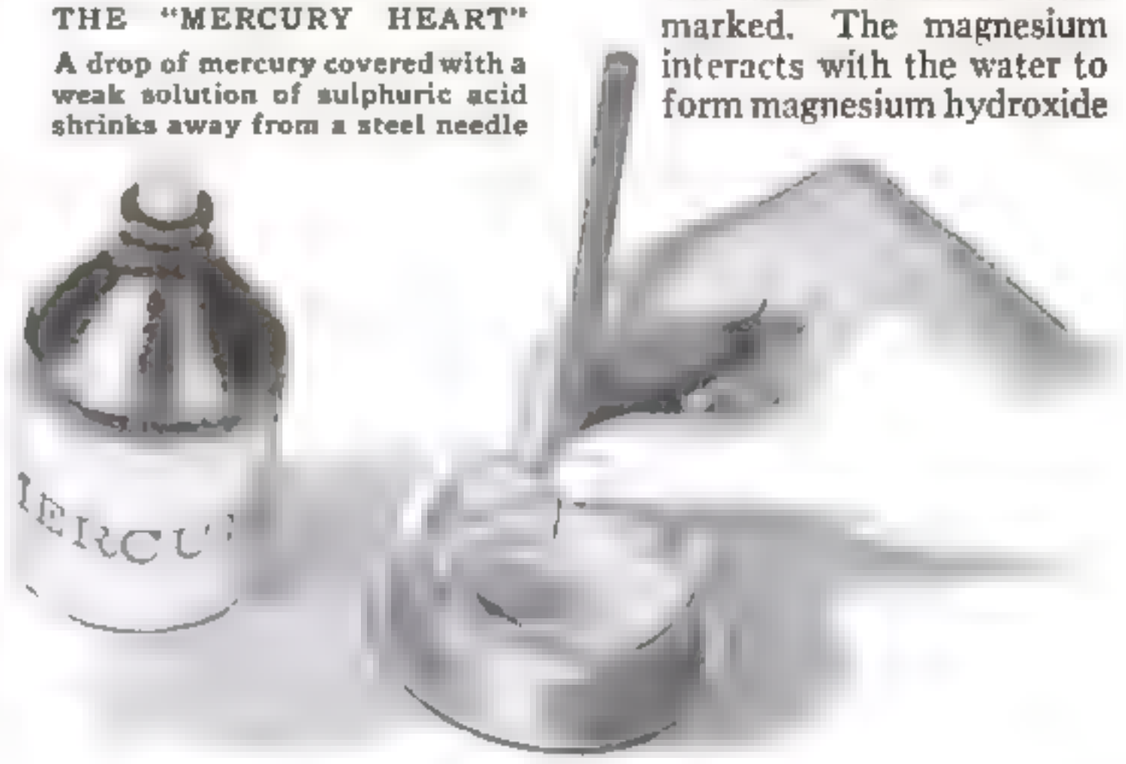
Only a drop of the liquid metal is required for a striking demonstration known as the "mercury-heart" experiment. Place the mercury in a small, shallow vessel—a glass caster well from the ten-cent store will do nicely—and cover the drop with a dilute solution of sulphuric acid. One part of strong acid to six parts of water makes a suitable solution, which should be colored faintly purple by the addition of a drop of potassium permanganate solution.

Now thrust a sewing needle into the solution from the side, jabbing the point into the drop of mercury, and you will receive a surprise. The drop will hump itself up, as if alive, and retreat from the needle. No sooner has it done so, however, than it flattens out again, repeating the pulsation each time it comes in contact with the needle point.

The same materials will serve for a "tidal-wave" experiment. Only enough of the colored acid should be used, this time, to encircle the drop of mercury, leaving its upper surface uncovered. Hold the needle vertically and touch it to the surface of the mercury drop. Then draw the needle sideways until it just meets the solution. Immediately the mercury gathers itself up about the needle, while the solution backs away. The mercury then relaxes and flattens out as before. The pulsation will continue for a considerable time. Changes in the surface tension of the mercury, caused by the electrical action of the metals and the acid, account for the remarkable behavior of the drop of metal in these two experiments.

Alloys of mercury with other metals are called amalgams and one of the most curious of these is a double amalgam known as Mackenzie's alloy. To make it, grind together in a mortar one part of mercury and two parts of bismuth metal, by weight, until a homogenous product is obtained. This is a bismuth amalgam. Make a lead amalgam in the same way, using three parts of mercury and four parts of lead, again measured by weight. The bismuth amalgam and the lead amalgam are both solids at ordinary temperatures. Place some of each in your palm and rub them together. Presto! They are transformed into a liquid alloy that you can pour freely from hand to hand.

An amalgam of magnesium metal and mercury may be made by rubbing the two together in a mortar with a pestle. Considerable heat is liberated as the metals unite, if the magnesium is in powdered form. The magnesium alloy that results is notable for its ability to decompose water, releasing hydrogen gas. Heating the water will make the effect more marked. The magnesium interacts with the water to form magnesium hydroxide



THE "MERCURY HEART"

A drop of mercury covered with a weak solution of sulphuric acid shrinks away from a steel needle

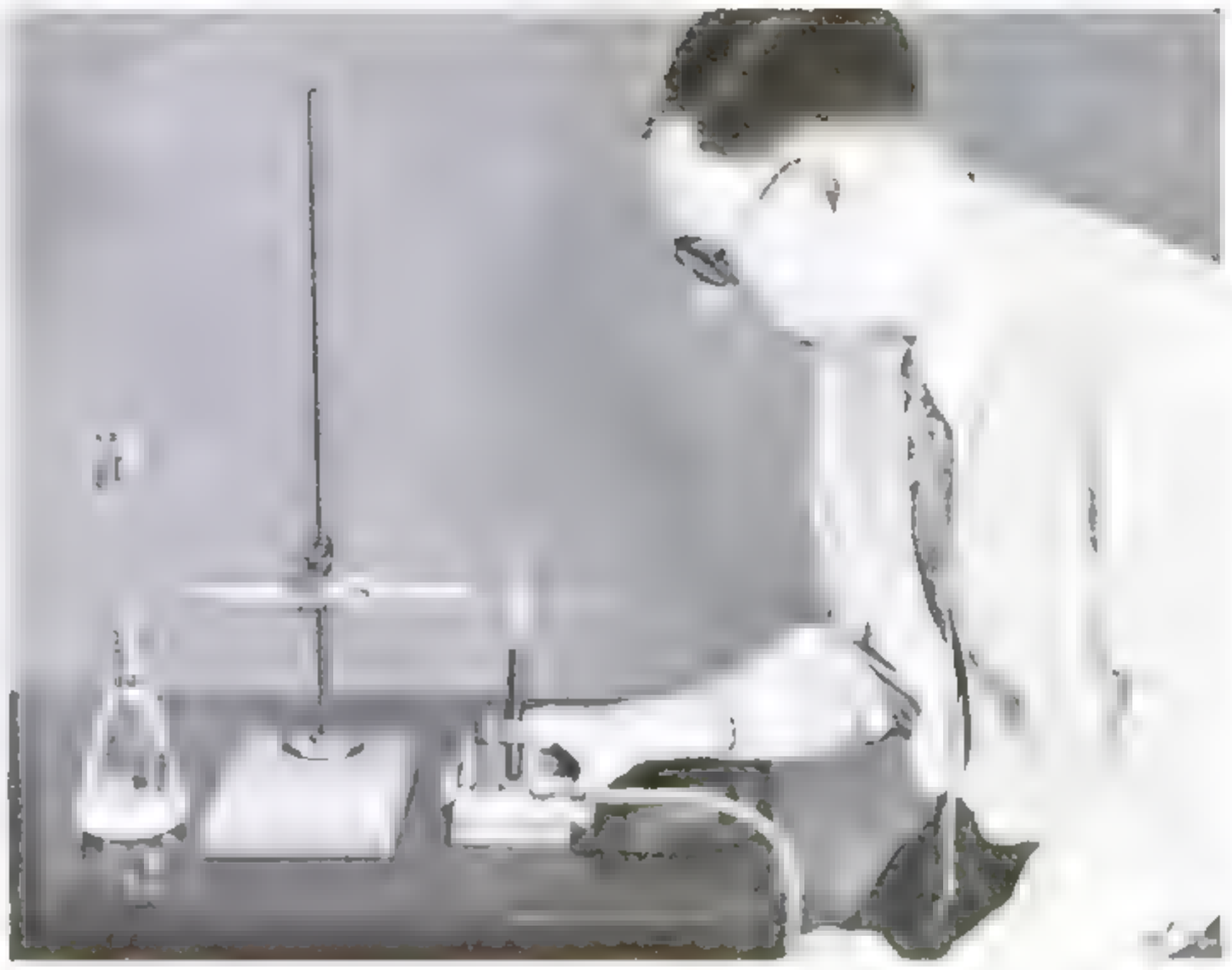
HOME-LABORATORY STUNTS WITH Mercury, Antimony, and Bismuth

or oxide, while the mercury can usually be reclaimed at the end of the experiment.

A few hints on working with mercury in the laboratory will not be amiss. Because of its propensity for forming amalgams with other metals, a wise precaution is to remove any valuable rings from the fingers before handling it. Gold and silver, by contact with mercury, quickly acquire a silvery coating of amalgam. If a piece of jewelry is made entirely of gold, however, and contains no stone or part that might be damaged by heat, the mercury may be volatilized and driven off by heating the article gently.

Spilled mercury is elusive, but may be picked up with a thin scoop of stiff paper, if the drop is first wetted. Mercury can be cleaned by filtering it through chamois skin, applying pressure with the fingers if the quantity is small. Shaking mercury with weak nitric acid (about an eight-percent solution) is another way of purifying it. This tends to dissolve any foreign metals that may be present as impurities.

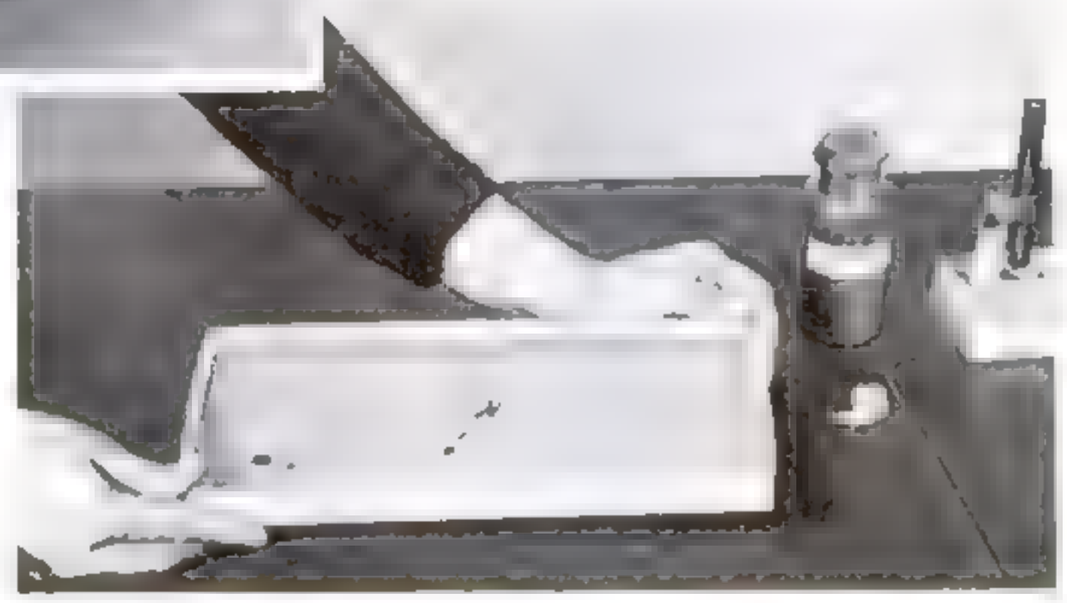
Two of the most interesting metals for home experiments are antimony and bismuth—a pair so alike in their properties that they might be called chemical brothers. You might search your house high and low without finding either of these elements for they appear in everyday life only in the form of a few compounds. Ask for bismuth at a drug store, for example, and you are likely to get the subnitrate or subcarbonate, which are used medicinally for certain stomach disorders. Antimony is contained in potassium antimony tartrate, more familiarly known as tartar emetic. The most striking experiments require the metals themselves, however, and these may be obtained from dealers in chemicals, usually in the form of lumps and powder mixed.



Solutions to be tested for antimony are admitted to a flask in which hydrogen is being generated. If antimony is present, it will form a characteristic deposit in the heated outlet tube

"MILK" FROM YOUR WATER FAUCET

Plain water, added to a clear solution of chloride or nitrate of antimony or bismuth, causes a white precipitate to appear, making it seem as though milk is being drawn from the faucet. At right, a pellet of burning antimony is bouncing around in a cardboard-box lid, leaving a trail of its course as it scorches the surface



By passing an electric current through a couple or junction of antimony and bismuth, you can produce either a heating or a cooling effect at will. This strange phenomenon is known as the Peltier effect, after the French scientist who discovered it in 1834. To demonstrate it, you will need a fair-size lump of each metal. The pieces should be attached with bare copper wire to a pair of long, metal knitting needles passing through the cork of a flask or bottle and serving as supports. Adjust them so that the lumps of antimony and bismuth are in contact with each other. If the lumps available are not large enough, you can form pieces of the desired size by melting the powdered metals and casting them in a paper mold. Pass a glass tube through a third hole in the cork and place the flask tightly on the cork. The apparatus should be arranged so that the glass tube dips into a beaker or small wine glass filled with colored water. The whole arrangement will act as a thermometer.

Now connect two or three dry cells, as shown in the diagram, and attach wires from them to the knitting needles, thus closing the circuit and setting up a flow of electric current through the antimony-bismuth couple you have made. When the direction of the current is from the antimony to the bismuth, the couple will be heated, the air in the flask will expand, and you will see bubbles of air emitted from the tube that dips into the beaker. But if the current is made to flow in the opposite direction, the junction of the metals is chilled, and the air in the flask contracts, as evidenced by the water rising in the tube. You are observing a remarkable phenomenon, *direct cooling* by an electric current which, if it could be applied practically to a device like an electric refrigerator, would eliminate all moving parts and produce a silent, efficient apparatus that would never wear out!

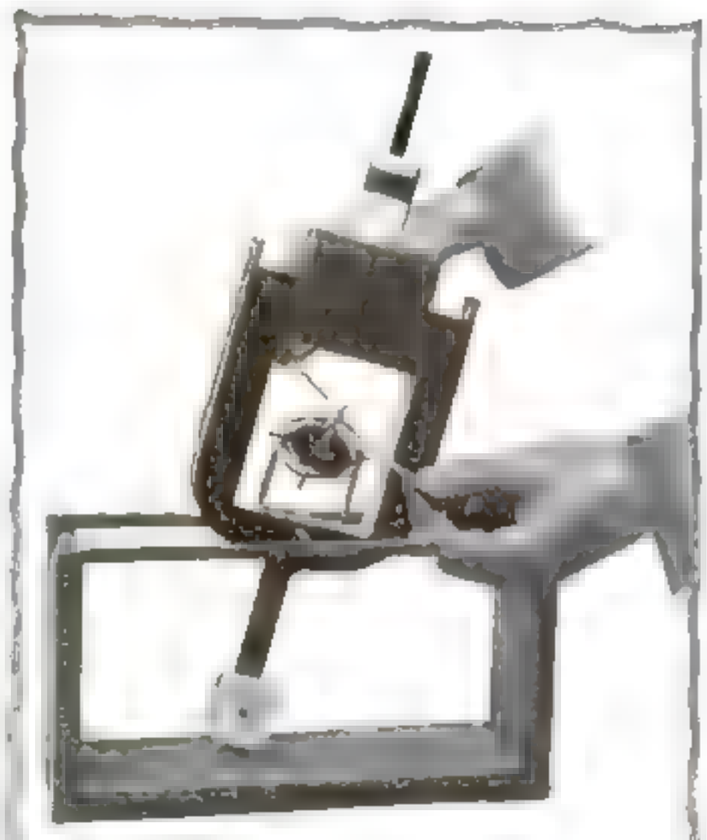
Once brought to its ignition point, metallic antimony burns in the air almost as readily as paper. You can show this by heating a pellet of antimony upon a charcoal block until it begins to burn, and then tossing it upon the inverted lid of a paper box. Rolling and bouncing from side to side, it continues to burn in the air as the coating of oxide that would smother it is continually knocked off. Its temperature becomes high *(Continued on page 123)*

ANYONE CAN PERFORM THESE

Easy Scientific Tests

Rolling Salt Box Proves Familiar Law of Physics

WITH the simple apparatus shown above, you can show that, provided there is little friction, the final speed of an object rolling down a hill depends only on the incline's height. First mark one end of a round salt box with thirty-six radial lines. Then make an incline with a board and a few books and adjust the height so that, when the box is rolled down it, the lines appear to stand still as it passes the bottom under the flickering light from a sixty-cycle, alternating-current lamp. The final speed, as gauged by the stationary-appearing lines, will be the same for any incline of the same height, whether the slope is steep, gentle, or curved.



Model Demonstrates Gyro Stabilizer

A CROSS SECTION of a ship, balanced by a pendulum as illustrated above, shows how a gyroscopic stabilizer works. The toy gyroscope is mounted so that it can be tilted in the fore-and-aft direction by means of a string held in the hands. Spin the gyroscope, and rock the ship back and forth on its cradle; then, by pulling the strings to and fro in the proper rhythm with the rolling, you can steady the "ship." When the gyroscope is left free, it swings back and forth of its own accord as the model rocks. To stop the rolling, you pull the gyroscope in the direction of its natural tilt, but a little ahead of the motion caused by the rocking. This is just what is done in actual ships equipped with gyroscopic stabilizers, the tilting being done by means of a motor and gears controlled by the position of the ship. In the model, the stabilizing effect is very pronounced.

How Fish Can See Under Water

PUT a piece of newspaper in a basin of water and try to read it with your eyes under the water. Even the large letters will be blurred. Then hold a clear, glass marble, about three quarters of an inch in diameter, in front of one eye and again put your face under the water, and you will be able to read the printing easily. Humans cannot see clearly under water because their eyes are adjusted for use in air, not water; the lenses in a fish's eyes are round like a marble and have a shorter focal length than those in a man's eyes. Any lens, or combination of lenses, with a focal length of about a third of an inch will correct your eyes for seeing clearly under water, as in this easy demonstration.

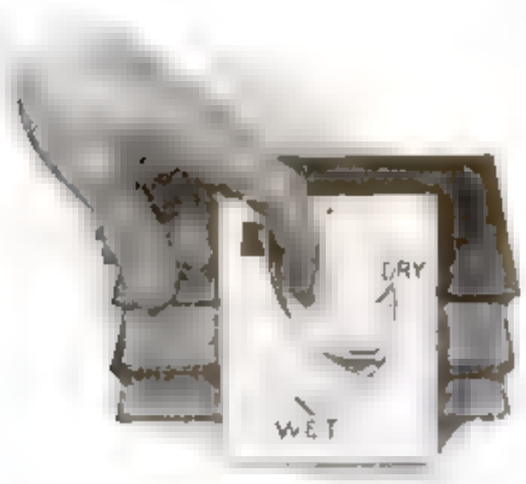


Photo-Printing Paper Is Simple Moisture Gauge

A STRIP of photographic printing paper mounted as shown above, with the picture side toward "dry," makes a simple moisture gauge. Place your finger near it, as illustrated, and the paper will begin to straighten out as the moisture evaporating from the skin comes into contact with it. The paper is very sensitive to moisture.

Strength in Sand and Paper

LOOSE, dry sand and paper may be formed into a strong column as demonstrated in the photograph. The paper is rolled into a cylinder two layers thick, and filled with sand. Weight on the top is distributed as lateral pressure against the paper walls, which are held firmly distended. The column does not give way until the paper cylinder bursts, and will support more than 150 pounds. This principle is commonly employed in construction work.

Gas Mantle Gives Off Invisible Rays

INVISIBLE rays from the thorium oxide contained in a gas mantle will penetrate black paper and affect a photographic film. Wrap a small section of film in black paper and lay a piece of a gas mantle on it. After three or four days, develop the film, and the clothlike texture of the mantle will be plainly visible. The rays emitted by thorium oxide are similar to those from radium, though much weaker. Its use in gas mantles does not depend on this property.

Top Times Speed Of Lightning

You can learn some curious facts about lightning flashes with a top made from a cardboard disk and a pencil. Draw a heavy black line on the top, as shown, and spin it in the dark near a window during an electrical storm. Most flashes will reveal the line as clearly as if the top were standing still; you may find that others consist of several discharges close together, showing motion in the top. Certain kinds of lightning will light up the disk, but will not reveal the black mark.

A PAGE OF NEW IDEAS

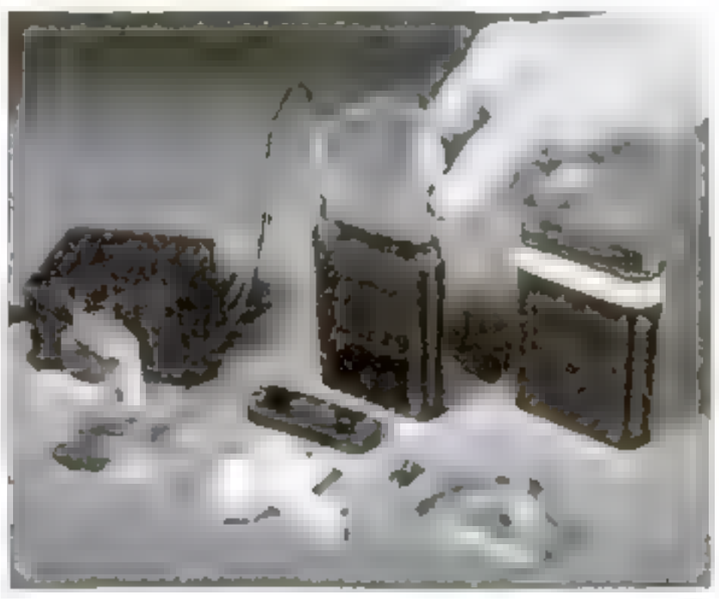
For the Radio Fan

Portable Cabinet Holds Tools and Spare Parts

For the radio experimenter whose laboratory consists of one corner of the kitchen table, the portable cabinet illustrated provides a handy means for storing spare radio parts, tubes and tools. Made of metal and provided with four roomy drawers, two shelves, and three other compartments, it can be carried easily and stored in one corner of a closet. Tight-fitting doors keep out dust.

Tiny Storage Batteries For Midget Receivers

Tiny storage batteries little larger than flat flash-light cells are now available for use in portable receivers. Manufactured in three sizes—two, four, and six volts—the units can be recharged simply by connecting them to a small, self-regulating charger. Plug-in terminals make it easy to connect them into the receiver circuit.



Midget storage battery connected to a charger

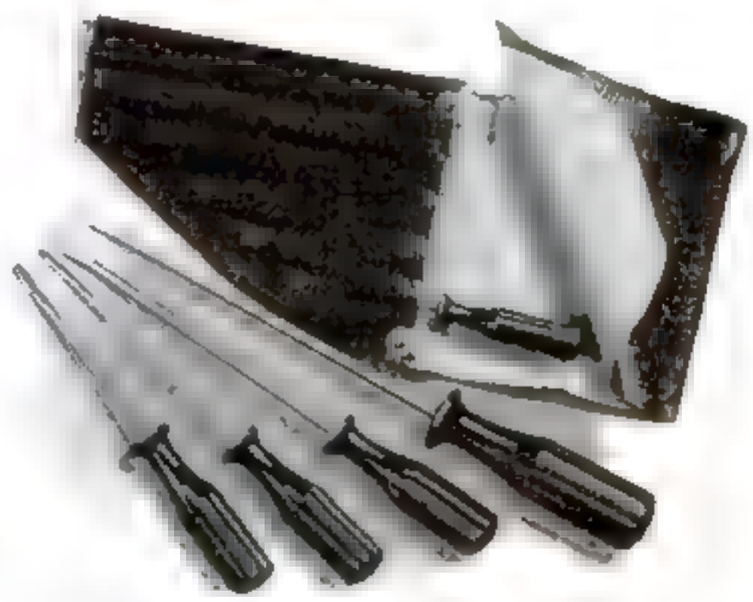
Mike Has Own Volume Control

To provide a positive and convenient method of sound control, the latest in public-address microphones contains a built-in volume control. Besides eliminating feedback, it promotes efficiency and ease of operation, especially when more than one microphone is used at a time, since it eliminates the use of a mixing panel. Turning the knob controls the volume.

Public-address microphone with built-in unit for volume control

Handy Kit Contains Five Screw Drivers

Having the right screw driver handy at just the right time is an important factor in set building and repair. A new five-in-one kit recently placed on the market contains five screw drivers ranging in size from 4¾ to 10¼ inches long. Designed especially for radio work, they have slender carbon-steel shanks mounted rigidly in insulated handles which protect the user from the possibility of shocks.



Switching Cord Gives Remote Control

With a recently developed switching cord, it is a simple matter to provide remote control for any radio receiver. Connected into the circuit at the wall outlet that provides current for the receiver, the control cord makes it possible to turn the radio on or off from your favorite arm chair simply by pressing a convenient hand switch. If the switch is mounted near the telephone, the radio can be silenced easily when a call is being made. The cord also can be used as a remote-control switch for bed-table lamps, cellar lights, or electrical appliances. The cord is furnished in a standard length of twenty-five feet.

Below, switching cord connected into circuit at outlet

The switching cord in use for remote control of a radio receiver. It can also be used for controlling distant lights or appliances

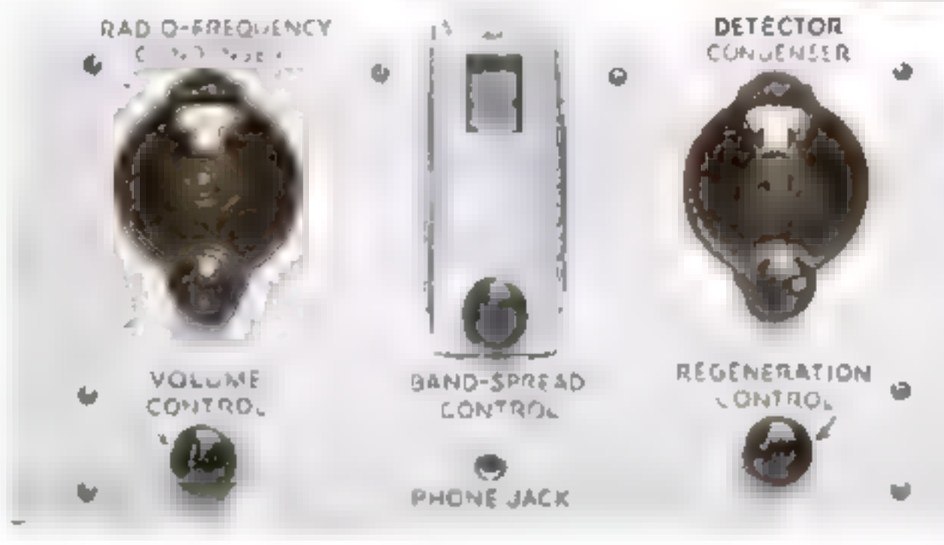
Simple SHORT-

Straightforward Design and Wide-Open Layout Make This Receiver Practically Foolproof in Operation

By J. B. CARTER

The set in use with headphones. A jack on the panel automatically cuts off the loudspeaker

A coil being inserted in the receiver. Note the rack at the rear of the chassis for protecting coils not in use. At the left is a view of the panel



FOR the radio experimenter who wants foolproof reception and ease of operation, the easily built short-wave receiver illustrated leaves nothing to be desired. No tricks or complicated hook-ups are used to bring in the elusive foreign programs, yet its volume is often enough to overload the average small speaker on many stations logged.

The main virtue of this receiver is its straightforward design and wide-open layout. Shielding cans have been made large and the chassis roomy so that parts can be mounted without the aid of a shoehorn. Not one connection in the entire circuit requires skill beyond that of the average beginner. Every part used is standard and easily obtained.

Fundamentally, the receiver circuit consists of one stage of tuned radio-frequency amplification, (6D6), a regenerative detector (6D6), and one stage of audio amplification ('76). A type 2A5 power pentode and a power supply, which utilizes an '80 rectifier, is built on a separate chassis. This allows greater flexibility, since the receiver may be used separately as a portable with batteries, while the power supply with the amplifier can be used independently in conjunction with a phonograph pick-up or any receiver requiring up to 100 milliamperes of current. The two circuits are connected through a five-wire power cable and two input wires.

Designed for use with either headphones or loudspeaker, the receiver has a jack on the front panel which automatically cuts off the speaker as soon as the phones have been cut into the circuit.

In constructing the original circuit, all short cuts and tricks were eliminated to insure sure-fire operation. The radio-frequency stage is designed to give maximum amplification without interaction with the detector due to stray coupling. It is fully shielded both below and above the chassis. The volume control (R_3) is also included in this stage. Usually the regeneration control is used for both regeneration and volume, but since such an arrangement generally results in several forms of distortation. two distinct units—a volume control and a regeneration control—are used.

This additional control contributes several other advantages: With it, the detector tube may always be operated on that portion of its characteristics at which best rectification is obtained with a resulting improvement in tone quality and detecting efficiency. The receiver also may be operated in the condition of maximum selectivity by setting the regeneration control close to the point of oscillation and controlling the volume separately at the radio-frequency stage. This latter feature is of particular value in bringing in a foreign station whose frequency is close to that of a powerful local.

THE usual regenerative detector with plate feed-back is used. The popularity of this method is shown by its continued use by beginner and old-timer alike. Regeneration is controlled by varying the screen-grid potential with a 50,000-ohm potentiometer (R_5). This provides smooth control on all bands.

Excessive radio frequencies are prevented from invading the audio-frequency circuits by using a carefully designed radio-frequency filter in the detector plate circuit. This helps to eliminate bothersome hand-capacity effects in all parts of the audio-frequency system, including the headphone and loudspeaker leads as well as the metal chassis and panel. Fringe howl, as the detector approaches oscillation, also is eliminated.

To provide real volume for a speaker, the output of the '76 amplifier is resistor-capacity coupled to the 2A5 pentode. This stage is built on a separate chassis together with the power supply. The high amplification factor of this tube and its medium power handling capabilities insure good volume even on the weakest and most distant signals. The output transformer (T_2) is mounted underneath the chassis with its secondary connected to the speaker terminal block, and is designed to operate a magnetic speaker or a permanent dynamic, having an output impedance in the order of 4,000 ohms. Of course, another type of transformer may be substituted to match any speaker desired.

While the power supply is entirely conventional, certain features have been included, to insure a trouble-free supply at the lowest possible cost. In many receivers, difficulty often is encountered in the form of a hum, especially the tunable variety, when the detector is oscillating. By choosing the proper components and observing certain precautions, this receiver can be made entirely free from hum, even when the headphones are used. As an ex-

WAVE Set EASILY MADE OF STANDARD PARTS

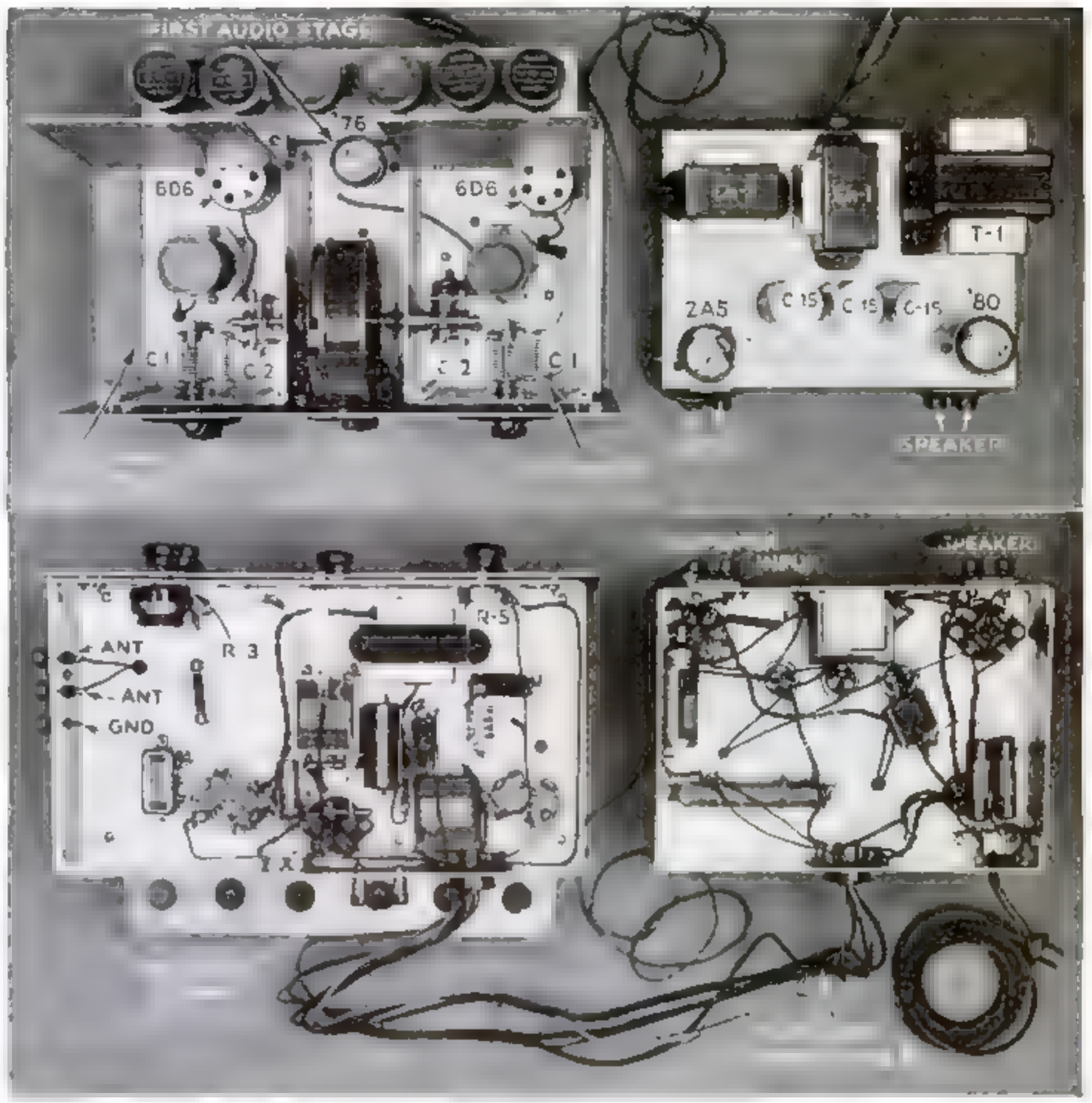
amination of the circuit diagram of the power supply shows, each side of the primary winding of the power transformer (T_1) is grounded with respect to radio frequency currents, through a .1-mfd. non-inductive condenser (C_{14}). Each side of the filament transformer also is grounded through a .006-mfd. condenser.

By employing band-spreading tuning, the process of separating stations, even on the higher frequencies, is greatly simplified. This receiver can be manipulated by ayone who has tuned a broadcast set. The simple procedure is as follows: Advance the volume control and adjust the two 140-mfd. main condensers to bring in a signal, keeping the two dial readings somewhat the same. Then advance the regeneration control until a rushing sound is heard in the phones or speaker and finally rotate the band-spread condensers attached to the center drum dial the same as if you were tuning a broadcast set. When a whistle is heard, back down on the regeneration control and slowly readjust the band-spread condensers for the greatest volume.

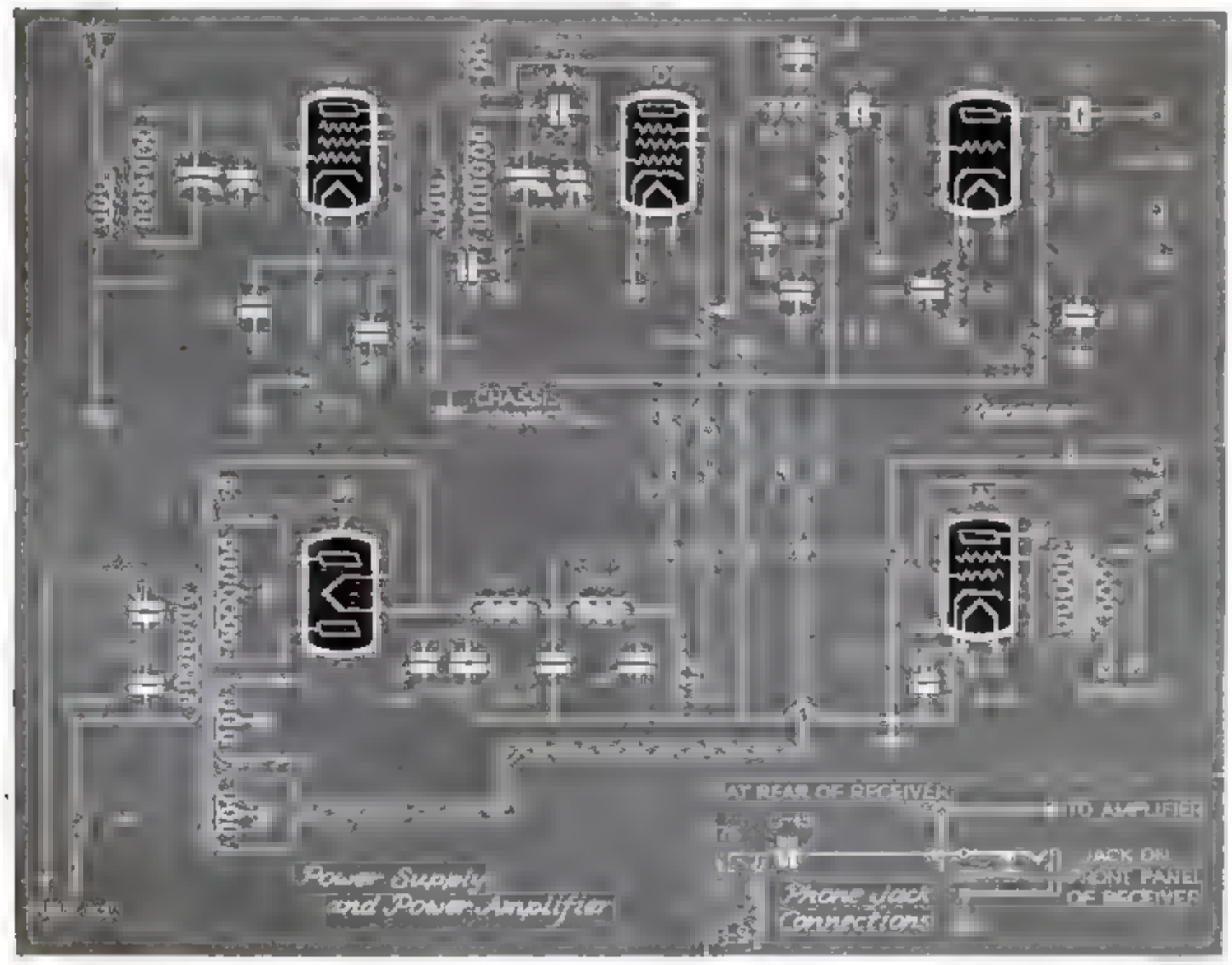
The fine results obtainable with this receiver are largely due to the very efficient shielding employed. For best results do not alter it. The radio-frequency stage and the detector are totally inclosed in separate shield cans.

Another valuable feature incorporated in the design is the provision for protecting coils not in use. A small aluminum rack mounted at the rear of the receiver chassis accommodates six plug-in coils.

Either a doublet or a standard antenna can be used with the circuit. Three binding-post terminals are provided on the receiver circuit—two for use with a doublet-type antenna, the third for the ground when a standard antenna is used. In the later case, a wire jumper is used to connect the second terminal to the third to provide a grounding connection for the lower end of the antenna coil.



Top and bottom views of the receiver, at right, and the separate chassis which accommodates the power supply. This arrangement makes it possible to use the receiver separately as a portable



Wiring diagrams for the receiver and power-supply units. A beginner can make all the connections

LIST OF PARTS

RECEIVER

C_1.—Variable tuning condensers, 140 mmf.
C_2.—Variable tuning condensers, 35 mmf.
C_3, C_4, C_5.—Fixed condensers, .1 mfd.
C_6.—Fixed condenser, 1 mfd.
C_7.—Grid condenser, mica, .0001 mfd.
C_8.—Fixed condenser, mica, .00025 mfd.
C_9, C_{12}.—Fixed condensers, 2 mfd
C_{10}, C_{13}.—Fixed condensers, .02 mfd.
C_{11}.—Fixed condensers, low-voltage, 2 mfd.
R_1.—Resistor, metallized, 100,000 ohm.
R_2.—Resistor, metallized, 250 ohm.
R_3.—Variable resistor, 10,000 ohm.
R_4.—Resistor, metallized, 5 megohm.
R_5.—Variable resistor, 50,000 ohm
R_6.—Resistor, metallized, 50,000 ohm.
R_7.—Resistor, metallized, 1 megohm.
R_8.—Resistor, metallized, 2,000 ohm.
R_9.—Resistor, metallized, 100,000 ohm.
R_{10}.—Resistor, metallized, 50,000 ohm.
L_1.—Set of four-prong plug-in coils
L_2.—Set of six-prong plug-in coils.
R.F.C.—Radio-frequency choke, 8 mh
Ch.—Audio choke.
Misc.—Tubes, aluminum shields, chassis, tuning dials, phone jack, binding posts, tube shields, wire, solder, etc.

AMPLIFIER AND POWER SUPPLY

T_1.—Power transformer.
T_2.—Output transformer.
Ch_1.—Choke, 8 henry.
Ch_2.—Choke, 30 henry.
C_{14}.—Fixed condensers, mica, .01 mfd.
C_{15}.—Electrolytic condensers, 8 mfd.
C_{16}.—Electrolytic condensers, low-voltage, 25 mfd
R_{11}.—Resistor, 15,000 ohm, 50 watt.
R_{12}.—Resistor, metallized, 500,000 ohm.
R_{13}.—Resistor, metallized, 500 ohm.
Misc.—Chassis, tubes, sockets, wire, cable, power cord, solder, etc.

Gus poked one potato sack down into the mud against the tire that was mired, and spread another in front of the wheel on the road

GUS TELLS WHAT TO DO . . .

When You're Stuck in the Mud

"COME ON, Joe! We're late now," Gus Wilson shouted, as he pulled up in front of the Model Garage. Joe Clark, his partner in the operation of the establishment, popped out of his little office and hurried over to the car.

"Gosh!" he exclaimed, eyeing Gus with admiration as he climbed in. "Nobody'll look at the bride, once they catch sight of all that glory!"

The veteran auto mechanic certainly was "all dolled up." From the crisp, new fedora that adorned his grizzled head, to the mirrorlike shine on his new shoes, not a detail was missing.

"And why not?" Gus asked, with a grin, as he let in the clutch. "A fellow doesn't have his favorite niece get married every day. I've got to do her credit. Now, if we can only get there in time."

The car splashed through a mud puddle and straightened out on the concrete as Gus gave it the gas. Looking back to see if any cars were coming from the rear, Joe caught sight of a heap of potato sacks, several blocks of wood, and a coil of rope on the floor of the car.

"I thought this was a wedding we're going to, not a kidnaping," he observed. "What on earth is all that junk for? Don't you think the minister can do all the hitching necessary without using rope?"

"Don't bother me with fool questions," snapped Gus, with a worried frown, as he glanced at the dash clock. "We've got to burn up the road to get there on time."

Joe realized, after checking the dash clock against his watch, that they really were quite late, so he kept silent. Gus's big foot had the throttle nearly down to the floor boards, and they whizzed down the state road far faster than was usual with Gus, who was ordinarily a very conservative driver.

"No more chance to make up time," Gus muttered, as they swung off the concrete onto a side road that seemed to be one vast sea of mud. Splashes of mud and dirty water soon decorated the car from stem to stern, as they skidded and slued around through the heavy going.

"By golly, now we can't be late; there's the minister," Gus grinned exultantly, as they rounded a turn and he caught sight of a small sedan with one rear wheel sunk nearly hub-deep in the mud just off what passed for the shoulder of the road.

"Hold everything, Doc," he shouted as the minister raced his motor and let in the clutch. The wheel that was sunk in the mud remained stationary. The other spun in the watery slime, sending up a shower of muck to add to the spattered design on Gus's car as he pulled past.

"Can't spoil that shine," Gus muttered, as he reached under the pile of potato sacks and pulled out an old pair of heavy, mud-stained shoes

After changing footgear, he sloshed over to the other car just as the Reverend John Gillespie, who hadn't heard his shout, was vainly endeavoring to get in a position where he could manipulate the clutch and at the same time watch the wheel that was in the mud.

"No use, Doc, the wheel won't turn," said Gus.

"Oh, hello, Gus! Have I broken an axle?" the minister asked

"If you had, neither wheel would turn around at all," Gus explained as he walked to the rear of the car and inspected the wheels.

"Well, it's a relief to know that nothing is broken," Gillespie sighed, thankfully. "I suppose you're on a hurry call, Gus, but I'll be mighty grateful if you can stop long enough to help me get out of here."

"Don't worry, Doc," Gus chuckled. "I'm sticking with you. Then I'll be sure not to be late for that hitching bee you're heading for!"

"Bless my soul!" exclaimed Gillespie. "I forgot, for the moment, that Marion Carter is your niece. How fortunate that you came along at such an opportune moment!"

"This is what the potato sacks are for, Joe," Gus said, as he picked out two of them and returned to Gillespie's car.

"Here's something to remember, Doc," he went on as he spread one of the sacks along the ground in front of the wheel that remained on the road and poked the end of the other down into the mud against the tire that was mired. "When you get stuck like this, it's mighty important to notice which wheel is slipping.

"If it's the one that's sunk in the mud, then the chances are if you get a potato sack or something else under that wheel to give it traction, you'll pull out all right. In this case, you've got to stop the slipping of the other wheel, too. Let in the clutch real easy now, Doc. That's another thing to remember when you're trying to get out of a hole in the mud. The easier you slip in the clutch, the better the chance that the wheels will take hold. There you are!" he shouted, as Gillespie's car crawled slowly forward onto the road.

"You go on ahead, Joe," Gus called to his partner. "I'm going to ride with the Doc." *(Continued on page 120)*

By MARTIN BUNN

HOW TO CONSTRUCT AN

Outdoor Fireplace

FOR PICNICKING IN YOUR OWN GARDEN

By Hi Sibley

Brick fireplace built against a wall in the garden of Frank Musetter, Altadena, Calif

YOU can often enjoy the pleasures of outdoor living no farther away from home than in your own garden. When there isn't time to take a long trip, when the roads are crowded and dusty, when duties prevent your going away, you can still have the fun of picnicking if there is an outdoor fireplace in your yard like any of those illustrated in this article.

An outdoor fireplace enables you to cook meals in real picnic fashion, and for some reason that always seems to make them taste twice as good as anything it is possible to prepare in the kitchen. You won't be alone in doing this, either, because the custom of lunching and dining outdoors is spreading rapidly. A number of requests have recently been received from readers for information on building outdoor fireplaces, and it is because of this growing interest in the subject that the accompanying practical, well-tested plans have been prepared.

In Southern California the outdoor fireplace has come to be an accessory that is second in importance only to the garage, especially in those localities where modern new homes are being built. The examples illustrated have therefore all been taken from that section of the country, where picnicking is a fine art.

The usual and most popular types of outdoor fireplaces are adapted to broiling or roasting meats and are familiarly known as barbecue ovens. Such fireplaces, of course, require a substantial foundation, especially in northern localities.

They are all comparatively easy to build. A pile of stone or old brick, a little cement and sand, and a piece or two of sheet iron are the essential materials. If these are on hand, the job is about as simple as building a house of blocks. The mortar commonly used consists of one part Portland cement and three parts sand. A little hydrated lime is often added to make the mortar easier to spread. About ten or fifteen percent as much lime as cement is the usual proportion.

In the drawings marked Fig. 1 is shown a design that can be built directly against a brick or stone wall, or isolated with a background of shrubbery.

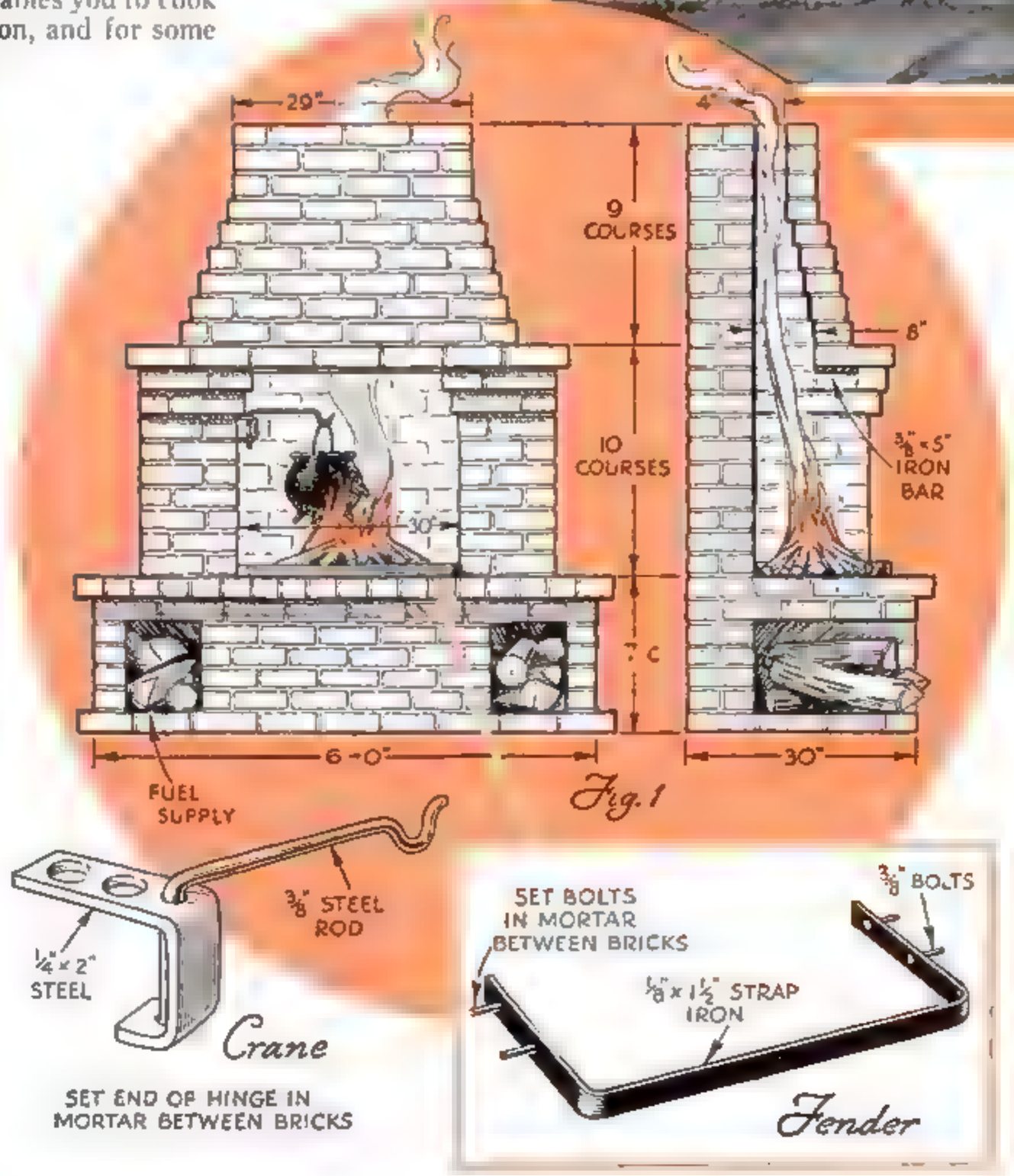


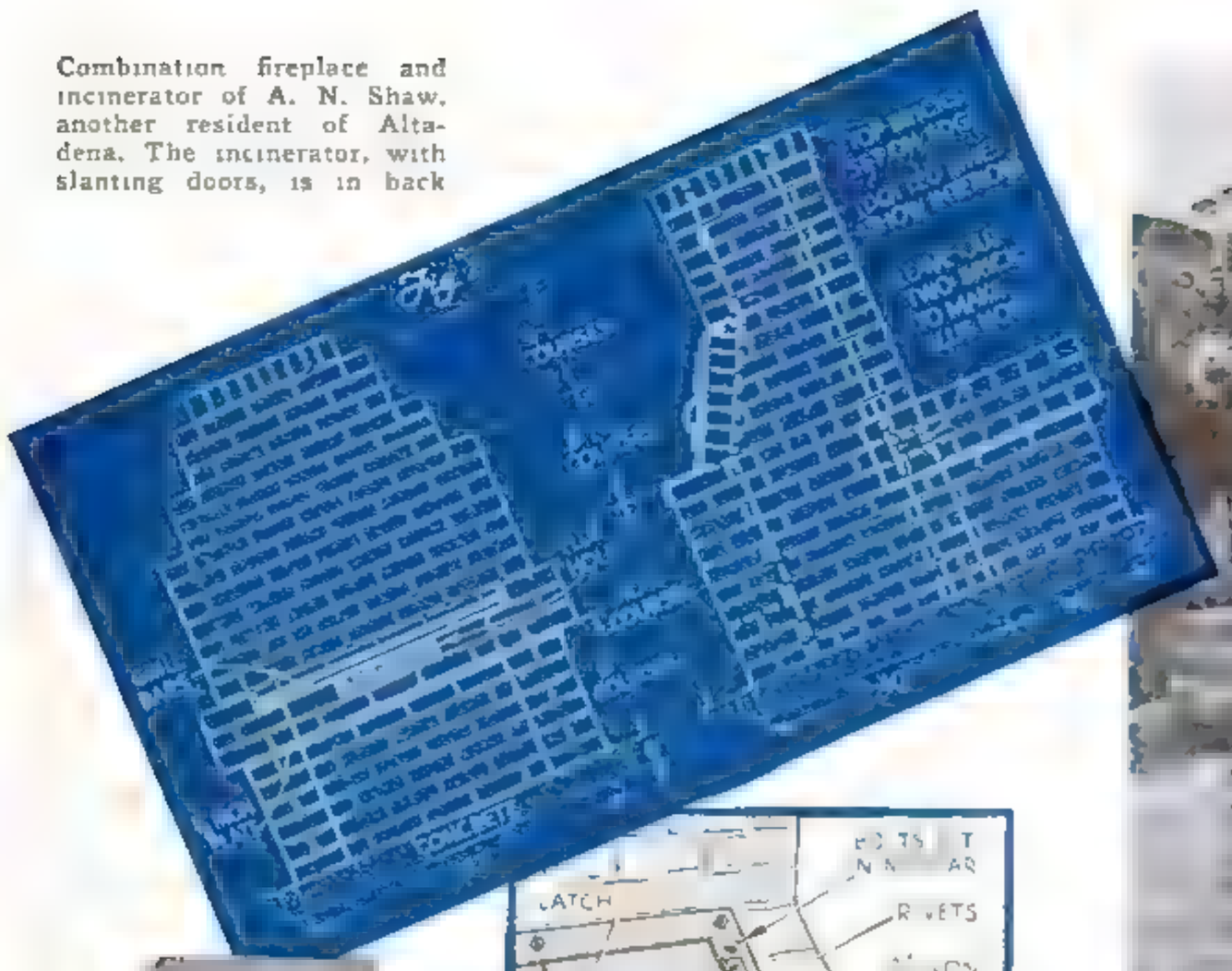
Fig. 1

Crane

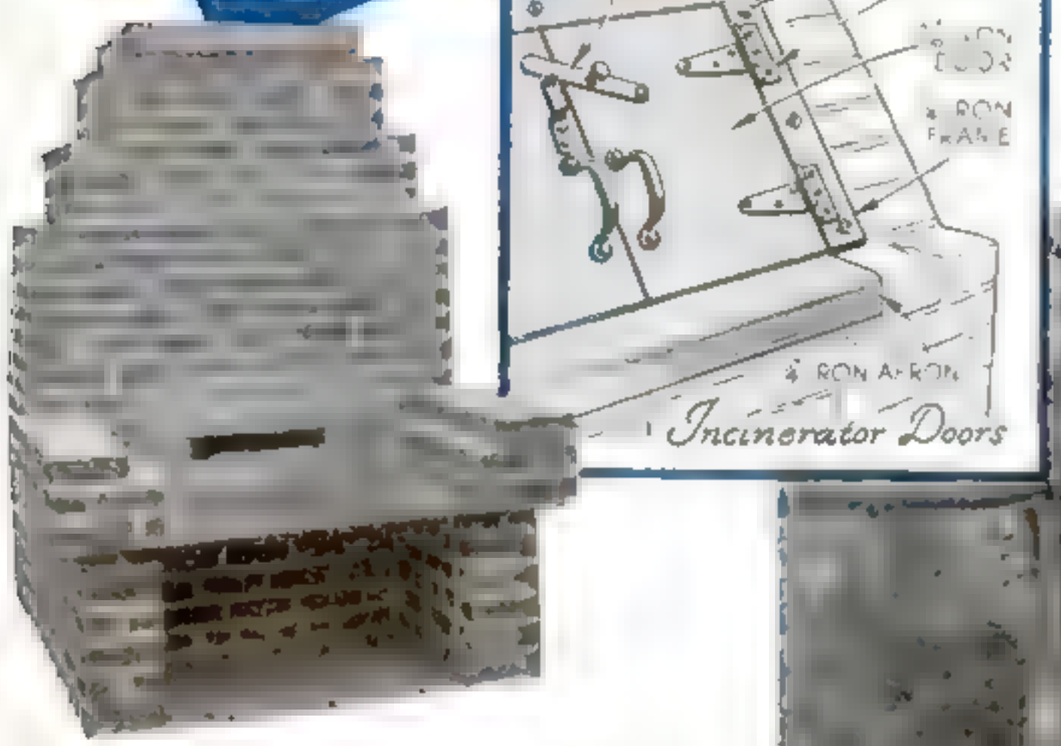
SET END OF HINGE IN MORTAR BETWEEN BRICKS

Fender

Combination fireplace and incinerator of A. N. Shaw, another resident of Altadena. The incinerator, with slanting doors, is in back



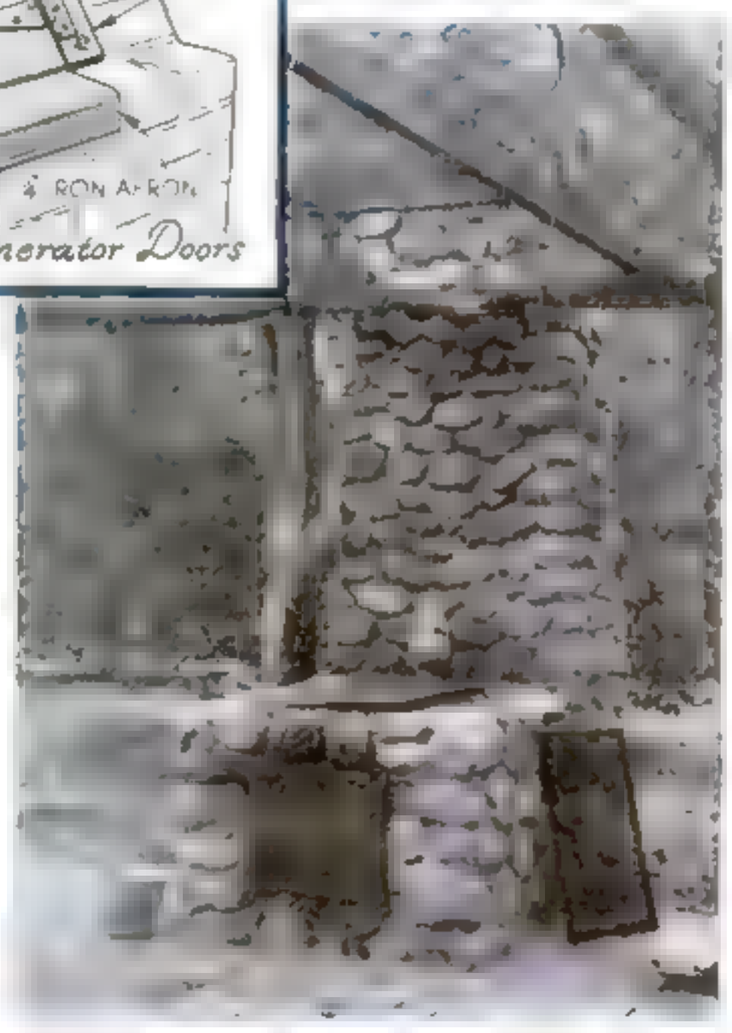
A side view taken slightly from the rear to show the opening into the incinerator section. Ashes are removed through a clean out at bottom



Wood is kept below the iron plate. The fire is built on the plate, and either a grill or a hot plate rests on a ledge two bricks up

The amateur can construct it simply by following the courses or layers of bricks as shown in the drawings and in the photograph of the completed fireplace at the beginning of this article. It should be erected upon a concrete or brick foundation. The crane support is embedded in the mortar or cement between two courses; and a flat iron bar is used to support the top of the fireplace opening. A rim or fender around the floor of the fireplace is made of flat bar iron, as shown.

The photo at right shows the fireplace marked Fig 4 in the drawings below



A larger brick structure is illustrated in Fig. 2. It serves the double purpose of incinerator and broiler. The incinerator is in the back and out of view from the garden. A novel arrangement of the fire-box is used in this design: the charcoal is placed upon a broad, flat iron plate, with the grill or hot plate directly above it a distance of only 4 or 5 in. This design, which is somewhat modernistic, is built of common red brick. The opening below the iron plate in front is used for storing a supply of wood.

An exceptionally attractive fireplace is illustrated in Fig. 3. It is built of varicolored natural stones, arranged in an interesting pattern. The owner used an oil drum for the fire box, after cutting away the ends and a *(Continued on page 104)*

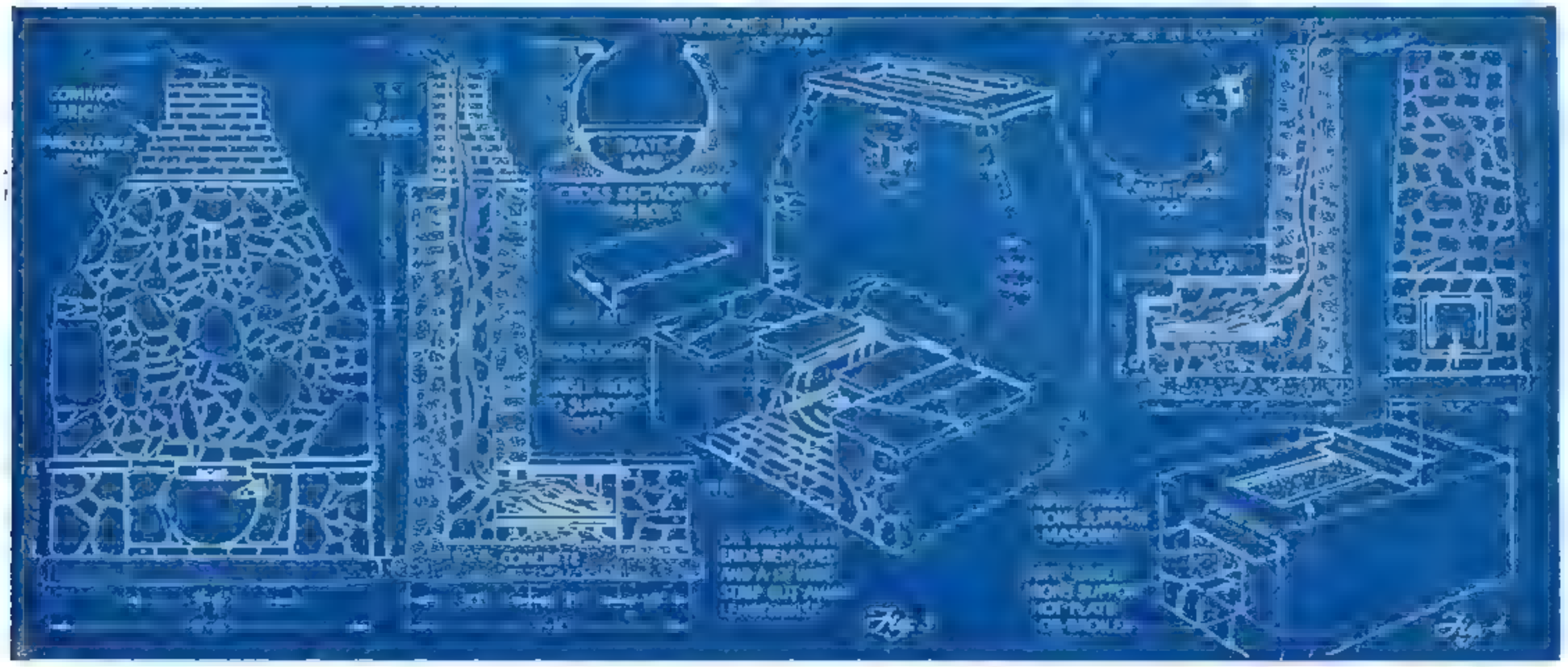
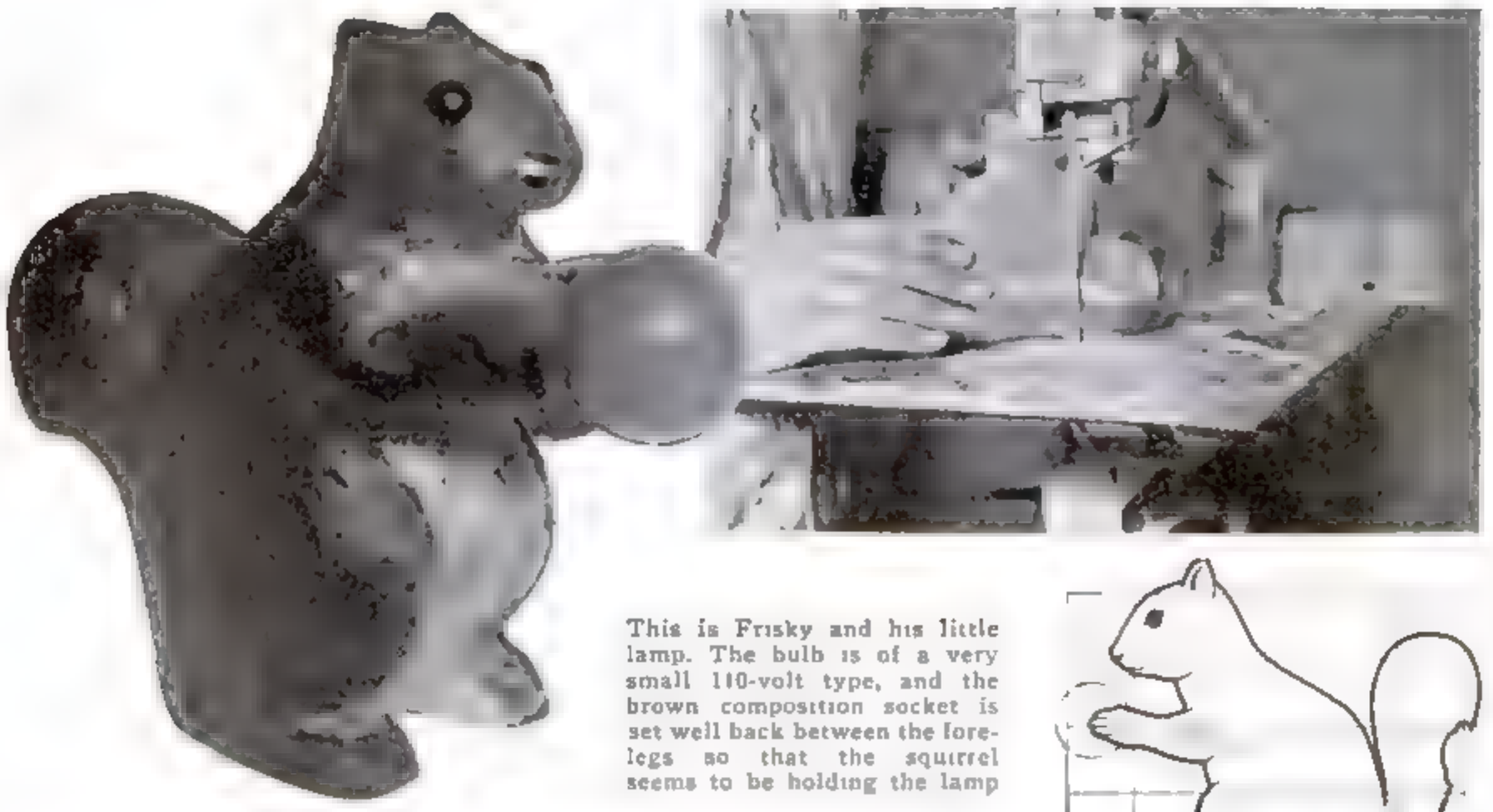


Figure 3 is a varicolored stone fireplace of E. L. McClelland, Pasadena, Calif.; Fig. 4, one of field stone built by Fenton Knight, La Canada, Calif.

Wooden Squirrel Holds Night Light



This is Frisky and his little lamp. The bulb is of a very small 110-volt type, and the brown composition socket is set well back between the forelegs so that the squirrel seems to be holding the lamp

The profile of the squirrel is first sawed from a 3-in. thick block, and the corners are trimmed off by tilting the wood

The body is finished with a router bit in the drill press. At the left is a pattern for the squirrel

FRISKY, the squirrel, with his small lamp is a night light for children. When tired little bodies are worn out from play, heavy eyelids would often shut much sooner but for some shadow over in the corner that is waiting for them to close before it turns into a big bear. If Frisky comes in holding his light, the shadow has to run away and hide, and even the most timid child can go to sleep in perfect safety.

To make this lamp is a one-evening job for the craftsman with a jig saw and drill press. The body of the squirrel is laid out on a piece of white pine 3 by 6 by 6 in. When the profile has been drawn, it is sawed to shape. Then the block is rotated, the corners are trimmed off, and the body is rounded up as far as practicable on the saw. After as much as possible of the excess wood has been sawed off, a router bit is put in the drill press, and the block is held in the hands while the shaping of the body is finished. The router is used to remove the wood between the legs and ears, and under the chin. Sanding is the next step, and this, too, is done on the drill press with a dowel covered with sandpaper.

Frisky's eyes are beads set into sockets in the head and fastened with very small nails.

For the lamp, a socket known as the intermediate or middle size is used. This socket resembles those used for Christmas-tree lights, but is larger and holds a bulb designed for 110-volt current without any other resistance in the line, and the bulb is so small that the current consumed is negligible. The socket, which should be a dark brown composition, is fitted between the front legs far enough back so that the squirrel appears to be holding the bulb between his paws. The wires are taken back through the body and out at one side. As the socket comes with wires sealed in, the splice should be made to the regular cord in such a way that it can be concealed in the body of the squirrel.

To finish, the body is given a coat of red-brown stain. When this has dried, it is sanded lightly to bring out enough of the white wood to represent the white hair in the squirrel's coat.

Boys and girls who aren't so small will like to have one of these novelty lamps for the mantelshelf or the radio, so it makes a novel and acceptable gift at any time.—D. C. MARSHALL.

MAKING EXTRA WEIGHTS FOR CHEMICAL SCALES

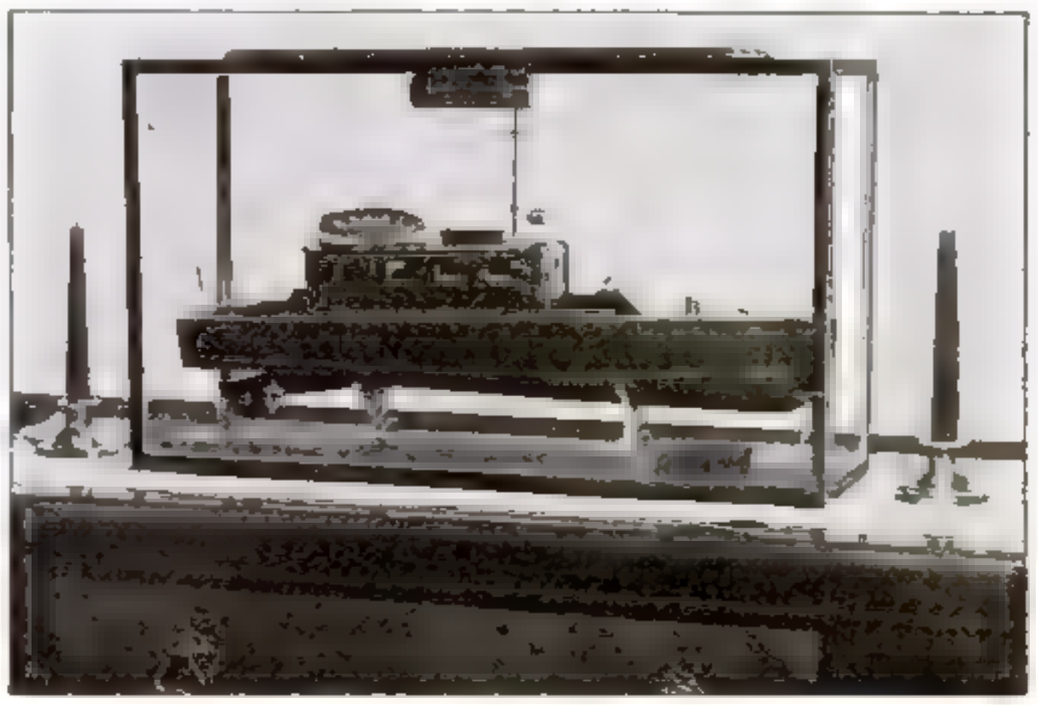
AMATEUR chemists and photographers sometimes lose the weights supplied with the inexpensive scales they ordinarily use, or need additional odd weights for making up certain formulas. Weights for either purpose can be made from common display card holders of the type shown. These have lead bases and are all over an ounce in weight. Lead can be removed as necessary with an old knife blade, and the lower surface later finished flat. Novelty stores usually have a supply of these card holders.—F. B.

AQUARIUM FORMS MODEL DISPLAY CASE

IT COSTS considerably more to buy parts and fabricate model display cases than it does to purchase production-made aquariums, which may then be converted into display cases quickly and easily. Still more important is the fact that much labor will be saved.

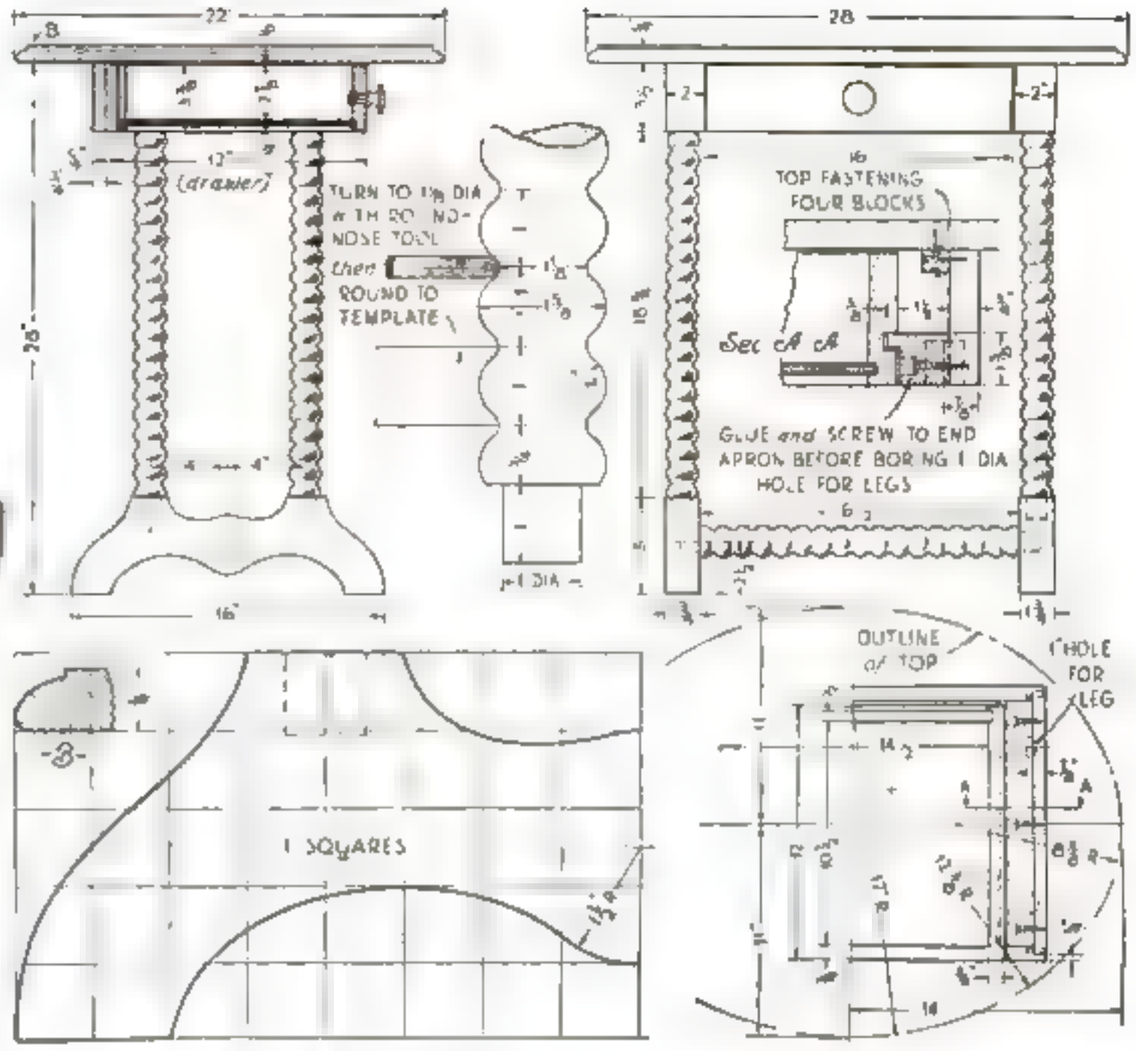
The case shown in the accompanying illustration is a typical example of a converted aquarium for such purposes. The case with glass cost only $5.50 as compared to an outlay of $9, had the frame been welded in a welding shop and the glass purchased separately.

These cases come in a large variety of sizes, and the only alteration necessary is the attachment of a suitable plywood bottom and cover. Small display lights may be installed and the bottom finished in a decorative manner. If boat models are to be placed in the cases, a background may be made of a water scene. If airplane models are used, the background may comprise a flying-field scene or clouds.



Many model makers dread having to make glass cases, but they can avoid the work by buying an inexpensive aquarium like that shown

FIVE USEFUL New Projects



CHARMING OLD-FASHIONED SPOOL TABLE GIVES GOOD PRACTICE IN TURNING

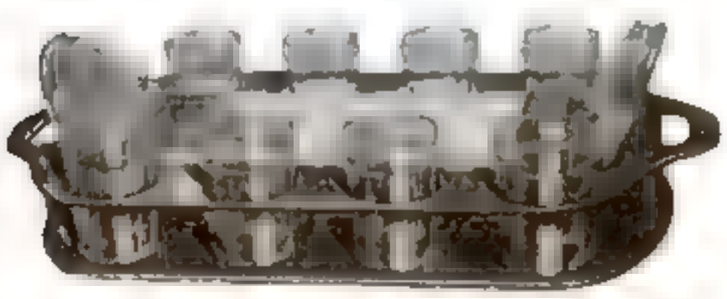
TABLES of the so-called "spool" type were among the homely charms of grandmother's house in the country, along with sea-shell doorstops and needlework mottoes on the wall. Their ease of manufacture by simple machinery probably accounts for their widespread sale during the latter part of the last century and no less recommends the design to the home craftsman who possesses a scroll saw and a lathe.

As an aid in interpreting the drawings, the list of materials will be given in exact finished sizes except where otherwise noted. All dimensions are in inches

Description	No. Pcs.	Size
Top	1	⅞ x 22 x 28 (elliptical)
Back apron	1	¾ x 3½ x 20
End apron	2	¾ x 3½ x 12½
Leg sockets	2	1⅜ x 1⅝ x 11½
Ends—front apron*	2	¾ x 3½ x 2
Drawer front*	1	¾ x 3⅜ x 15⅞
Drawer sides	2	½ x 3⅜ x 11¾
Drawer back	1	½ x 3⅜ x 15
Drawer bottom	1	¼ x 10⅞ x 14⅞
Legs	4	1¾ sq. (rough) x 20¾
Stretcher	1	1¾ sq. (rough) x 18½
Feet	2	1¾ x 5 x 16

*Make these parts from one piece of wood so grain will match when finished.

Any standard cabinet wood may be used, but cherry, maple, birch, or gum are recommended.—DONALD A. PRICE.



A double-decked tray with an enameled dish and spaces for eight glasses and small plates

UNIQUE TRAY CARRIES SERVICE FOR EIGHT

THE serving tray illustrated above is made of ¼-in. plywood built around a central receptacle, such as a cake tin, 2½ by 5 by 9 in., for sandwiches and cake. An accessory of this kind will delight the heart of any bridge hostess.

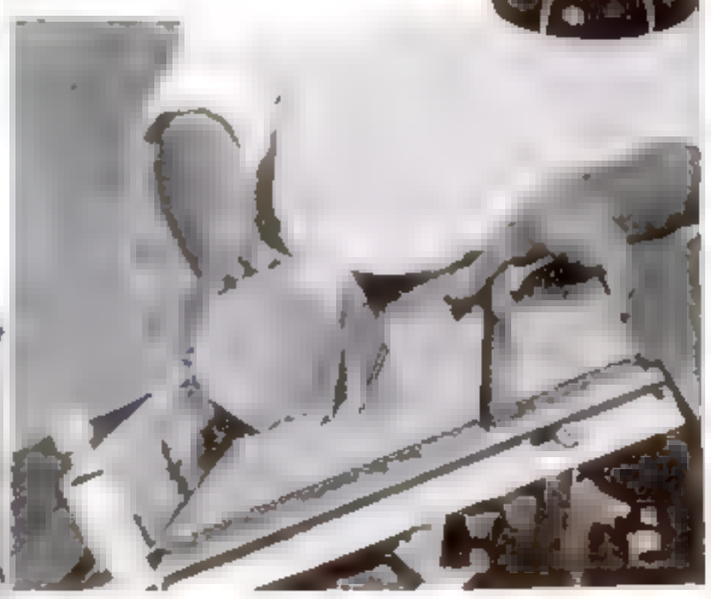
Along each side of the upper deck are circular holes, four on each side, to receive drinking glasses, which rest upon the lower deck. At each end of the receptacle is an elongated opening in the upper deck to receive a nest of four plates, which also rest upon the lower deck. The dimensions should be worked out to suit the receptacle, plates, and glasses used. Handholes are cut as shown in the upper deck, and at each end of these handholes the upper and lower decks are connected with ¾-in. round pillars to strengthen the whole structure.

The center receptacle is finished in high gloss white enamel, and the two decks are stained light mahogany, given three coats of rubbing varnish, and a final polishing with wax.—C. F. BLAKE.

LAMINATED CANDLE BASES

SMALL candle-base turnings of laminated wood like those shown at the right are attractive yet easy to make if the following procedure is used in gluing up the original block.

The material required for making four bases is two pieces of walnut 1¾ by 3⅞ by 10 in. and three pieces of holly ⅛ by 3⅞ by 10 in. Glue one piece of the holly between the two pieces of walnut and square up the block on the sides and ends. On one end inscribe the largest possible circle centered on the holly strip. Lay out a hexagon tangent to this circle, as shown in the drawing near the end of this article. On the circular saw, trim the block to these lines as illustrated at right below. Then, laying the sides *A* and *B* (see drawing) on the saw table, split the block through the center of the circle as shown in the photograph in the oval. However, before making this cut, drill two holes near each end for eightpenny finishing nails, which serve as dowels to line up the two halves when gluing them together with the second holly piece between. In the same manner glue in the third holly *(Continued on page 90)*



When the block has been glued up, it is trimmed to a hexagonal shape on the circular saw, as shown above, then split in half as illustrated in the oval at the left

for Amateur Woodworkers

Beginners and Advanced Craftsmen Alike Will Find Worth-While Plans in This Group, Which Includes a Spool Table and a Colonial Cabinet

Folding screen fitted up to take the place of a serving table. It is made as shown at left. When not in use, it may be stored away flat

WITH this novel service screen, which can be set up in any room, it is possible to serve luncheon or tea to four or more persons, yet keep all the necessary accessories concealed. Each shelf is hinged and folds into the recessed panels when not in use.

The construction is simple—merely three plywood panels over a light framework, and five shelves. Three of the shelves swing on hinges; the other two are pivoted on long screws. Additional shelves and racks can be installed to meet individual requirements.

Use ¾ by 1-in. white pine or redwood for the framing. To this fasten the plywood with finishing nails and glue. As none of the shelf hinges is screwed to the plywood, a thinner material can be used if desired, such as ⅛-in. pressed composition wood or wall board.

Note that the upper shelves have light rails to prevent glasses from sliding off. It would be easy to substitute racks for holding wine glasses in an inverted position. A bracket of bent strap iron swings out to support the triangular shelves, and a pin through them prevents any danger that the shelves will slip to one side.

There are many possibilities in decorating the face of the screens, either by covering with a figured cloth or embroidered Japanese silk, or by painting directly on the panel.—H. S.

DECORATIVE COLONIAL CABINET HOLDS BOOKS OR CURIOS

NEARLY every home can use extra shelves for books or for pottery, decorative metal work, and other ornamental objects that it is desirable to display. The colonial cabinet shown in the accompanying drawings provides one good answer to such a need. The small cupboard at the bottom is just the thing for current magazines; and the drawer may be used to hold pipe and tobacco, playing cards, or anything similar. Slender, graceful, and economical in the use of space—these are only a few of the features that will recommend the design to craftsmen.

A useful little cabinet. This design includes open shelves, a small drawer, and a storage cupboard built into the base

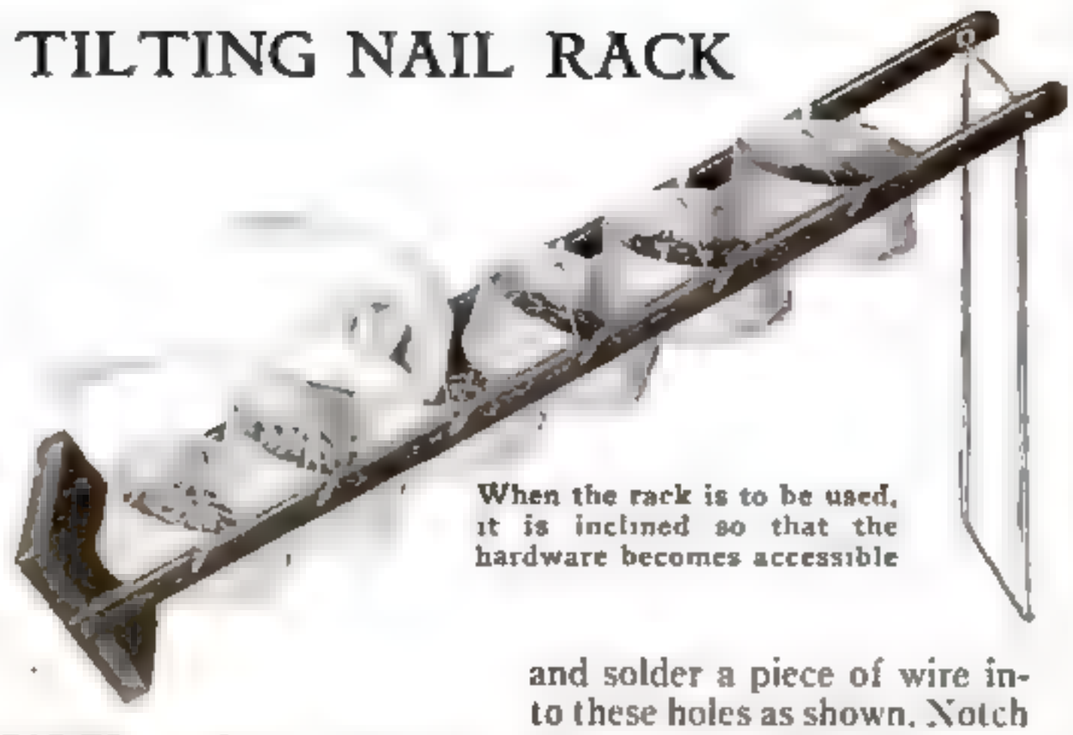
The cabinet may be built of oak, maple, walnut, mahogany, or pine. The drawings are self-explanatory, and the list of materials at the end of the article gives the finished sizes of the various parts. If it is desired to carve the face of the pediment, an involute scroll may be added (see P.S.M., Jan. '35, p. 67).

The small door at the bottom is interesting because of its raised arched panel and antique looking H-hinges. In case these cannot be bought or made, they are easily simulated to look like genuine H-hinges by the method suggested in the detail drawing. They should be painted a dull black when

(Continued on page 90)

COMPACT TILTING NAIL RACK

From six to twenty-four different kinds of nails, screws, and other small parts may be kept in this rack



When the rack is to be used, it is inclined so that the hardware becomes accessible

MODEL makers, amateur craftsmen, and others who keep on hand various sizes of bolts, washers, brads, and other small parts will find a container like that illustrated is convenient. It is portable and when not in use can be stored in a space 4 by 4 by 18 in. Six items may be stored, or if the pans are divided into quarters, twenty-four.

The oak base is 5/8 by 4 by 4 in., and the uprights are 3/8 by 3/4 by 18 in. The containers are made from tin cans 3 1/4 in. in diameter, cut down to a height of about 1 1/2 in. Punch or drill holes in opposite sides of each can about 1/4 in. from the top, and solder a piece of wire into these holes as shown. Notch the uprights with diagonal slots spaced every 2 5/8 in. The axles, supporting leg, and upper bar can be made from wire coat hangers. Old coat hangers, by the way, are a good source of supply when stiff wire is needed

When the rack is tipped, the weight of the pans will keep them in a horizontal position. To determine the length of the supporting leg, tip the rack until the bottom of each pan just rests on the rim of the pan directly beneath it and measure the distance from the cross bar at the upper end down to the table.—IVAN C. LUCKMAN.

WOOD-TURNING PATTERN TRACED FROM SHADOW

TO FACILITATE the accurate copying of a turned object or the turning of a number of like objects, a profile template of some sort is a necessity. A profile gauge is, of course, the proper tool to use, but many home workshops do not have one. An obvious, though often overlooked, method of making a profile template is simply to cast a shadow with the object, trace one half of the shadow on a card, and cut the template out.

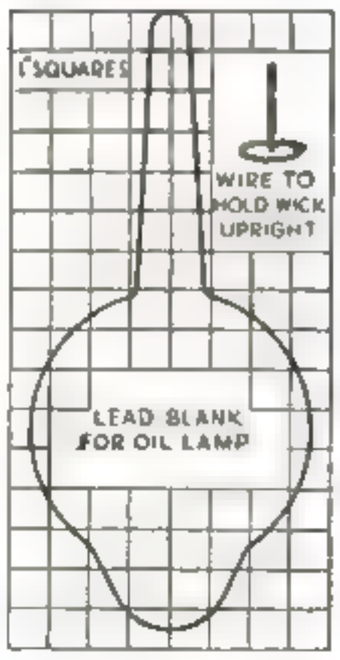
In order to cast an undistorted shadow, a clear incandescent lamp should be used as a light source, and it should be placed as far from the object to be copied as the size of the room permits. This helps to keep the shadow the same size as the object. The object should be set on a level with the lamp and perpendicular to the floor. The card should be placed close to, and squarely behind, the object, as shown below

More durable templates may be cut from sheet metal or plywood if a power jig saw is available.—E. L. BROKAW.

Tracing half the shadow of a candlestick to prepare a template for turning a duplicate

ANTIQUE-LOOKING NIGHT LIGHT

MADE from 1/8-in. sheet lead, the reproduction of an early American oil lamp shown at the right serves as a decorative, long-burning night light. The lead is cut out with tin shears and shaped by hammering on the inside to a depth of about 1 1/4 in., and this will bring the handle upright. Then go over the outside lightly with the hammer. Slip a length of candlewick over a piece of wire bent as shown, set it in the center, and fill the cup with melted tallow or paraffin, or half tallow and half paraffin. With the mixture mentioned, it burns about sixty hours on a single filling.—D. H.



The sheet lead is cut as at left and hammered into shape

HOLDER FOR DRY-CELL TESTER

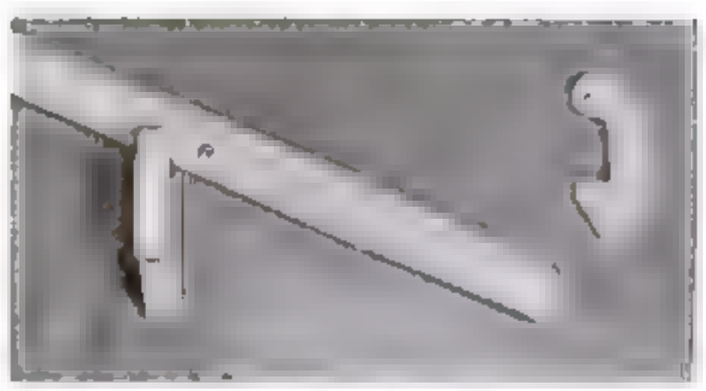
ORDINARY small dry-cell battery testers have a hard and dangerous life around the average shop where electrical repair work is done. To protect one of these instruments and at the same time make it more convenient to use, mount it on a medium-sized vacuum-type card holder as shown and snap the jaws of the clip on the edge of a metal tool box or any other suitable ledge or projection above the top of the bench. Bend the clip handles a trifle if necessary.—FRANK W. BENTLEY, JR.

Small battery tester fastened conveniently to the edge of a tool box

PENDULUM CATCH LOCKS DOOR BAR

A STURDY, foolproof wooden latch for the double doors of a garage may be made from scrap lumber as shown at the right. Bolt a "two by four" from 3 to 5 ft. long to one door about halfway up and 4 in. (this is important) from the edge of the door so that the bar turns freely on the bolt. Saw out a pendulum catch and fasten it so the long bar is horizontal when in the notch. Then notch a rather heavy piece and fasten securely to the edge of the other door as illustrated.

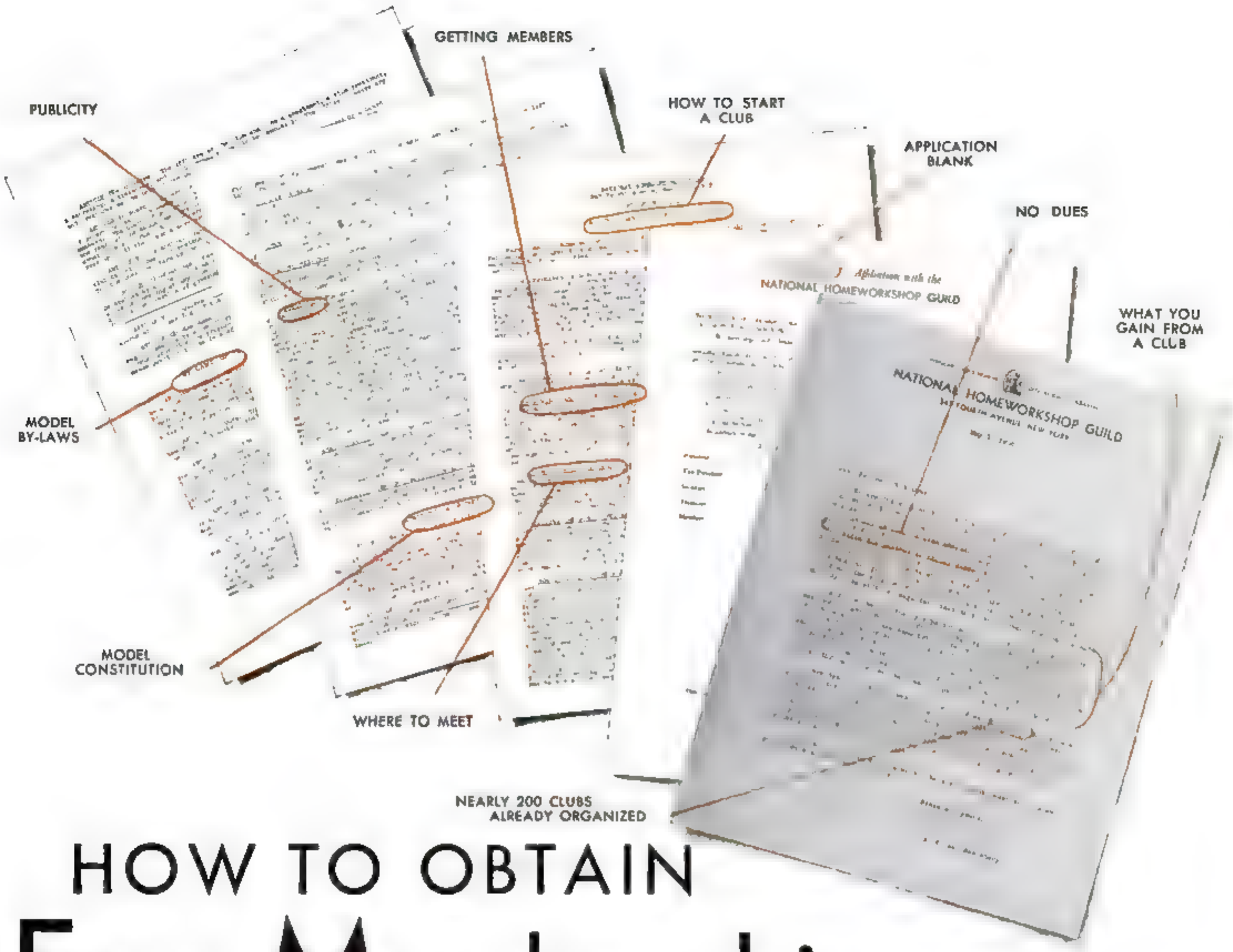
With the bar resting in the notch of the pendulum latch and behind the heavy notched piece, the door will be held against any intruder. This latch can be opened only from the inside by swinging the latch out of the way and turning the bar.—BROOKS HILL.



The bar, which is made from a "two by four," is held when horizontal by the catch at right

REMOVING BURR FROM SCREW

WHEN it is necessary to shorten a screw or bolt by cutting it off with a hack saw, run a nut on the screw before using the saw. Backing the nut off will then remove the rough burr from the end of the thread.—I. S. W.



HOW TO OBTAIN Free Membership

In the National Homeworkshop Guild

All this information is yours for the asking. It tells in great detail how to organize a home workshop club in your own neighborhood. Just fill out the coupon below and inclose a large envelope, stamped and addressed to yourself

SO GREAT was the response to the free membership offer made by the National Homeworkshop Guild last month (P.S.M., May '36, p. 61) that the officers and directors have now decided to abolish all national dues permanently. Membership in the Guild, instead of costing fifty cents a year, will hereafter be free.

To become a member of the Guild, it is necessary for you first to be a member of a home workshop club that meets regularly in your own city or town. If there is no club in your locality, you can organize one without difficulty or expense among your friends and neighbors. Provided the club has five or more members, all over sixteen years of age, and is willing to abide by the simple rules of the Guild, it can apply for a free charter in the Guild. Complete information on organizing a club may be obtained by using the coupon on this page.

If you are already a member of some home workshop or model making club that is not affiliated with the Guild, get up at the very next meeting of the club and offer a motion that it join the Guild at once. It can enjoy all the advantages of affiliation on the same basis as a new club.

Regular readers of this magazine are familiar with the great achievements of the Guild. They know it has been by far the foremost national influence in developing the home workshop club movement. For new readers, however, a summary of its purposes will be given.

What the Guild Is. A national organization founded in 1933 to promote the formation of home workshop clubs in the United States and Canada. It is strictly noncommercial and nonprofit and has but one concern—to give amateur craftsmen a chance to enjoy good fellowship in their hobby by meeting other men with similar interests. The Guild has an advisory council of nationally distinguished men, and its official magazine is POPULAR SCIENCE MONTHLY.

(Continued on page 98)

An affiliate card like this is issued to every member

National Homeworkshop Guild
347 Fourth Avenue, New York

I want to take advantage of your special free offer and organize a home workshop club in my own neighborhood. Please send me all the necessary information. I am inclosing a large (legal size) envelope, self-addressed and bearing a three-cent stamp, for you to use in sending me this material.

NAME.....

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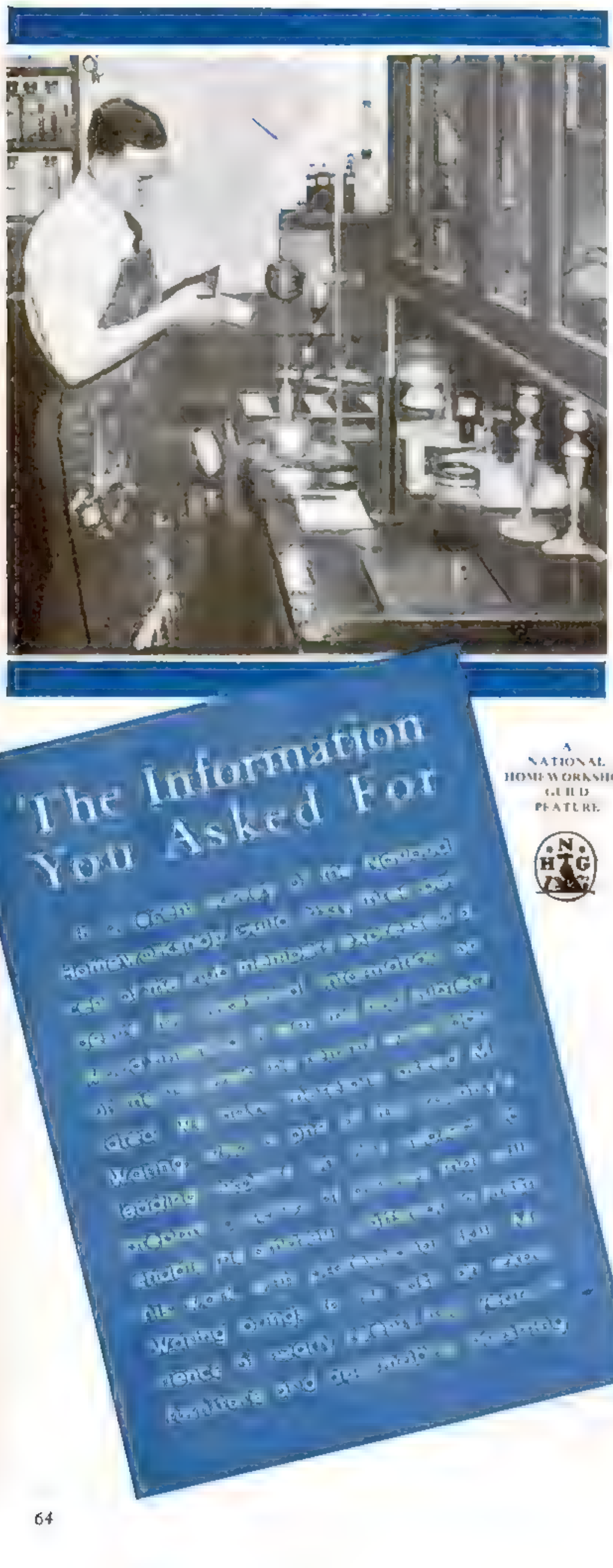
(Please print very clearly)

BETTER METHODS OF Finishing Furniture *and other* Woodwork



By *Ralph G. Waring*

Research chemist and specification engineer on paints, oils, varnishes, and stains

MEMBERS of the National Homeworkshop Guild take pride in making their products the finest of their kind. As often as I have seen their work in various splendid exhibits, just so often have I been filled with respect for the quality of their workmanship. For a long time, however, I have been puzzled about the finishes they use, or perhaps I should say, the modern and improved finishes available which they do *not* use.

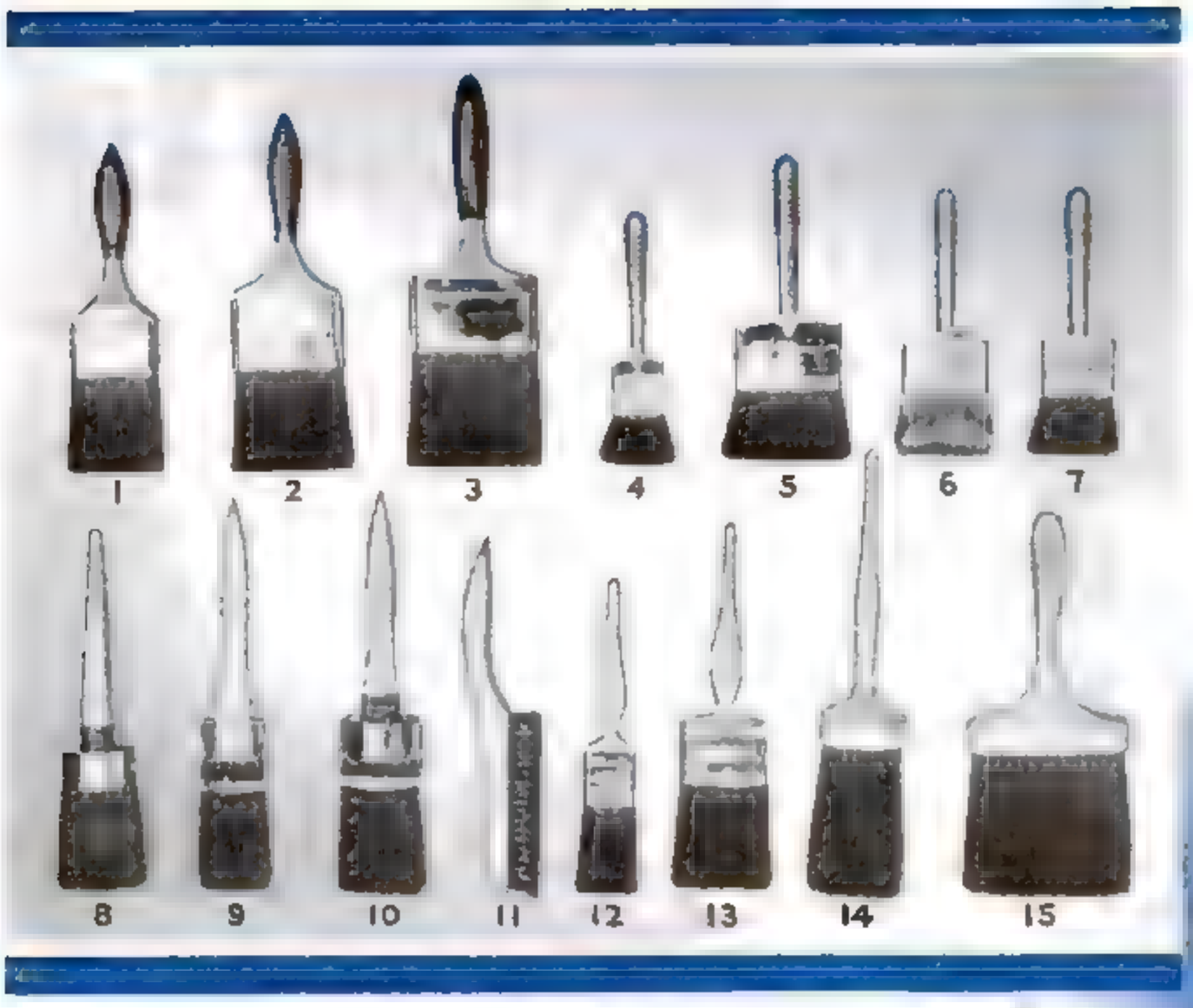
Let me quote a few statements I read in a recent article by a Guild member, whose ability as a designer and craftsman is beyond criticism: "Stained finishes are usually ugly, like other imitations. No amount or kind of stain will turn birch into mahogany, or deceive any but the most careless observer. An oil-wax finish on dark-colored woods is handsome, etc. . . . The underside of the top should be smoothed and given the same finish as the rest of the piece."

In the first sentence quoted I wish he had said "sometimes" rather than "usually." Almost any wood with equal factors of strength, good grain, or texture can have its native beauty enhanced by proper stains. It is quite true that the so-called "penetrating stains" cannot produce anything lasting or beautiful, since they have so little light resistance that they fade quickly. Water stains, on the other hand, produce clean bright colors of transparent depth that afford beautiful effects on even very ordinary woods. I have panels with what to me are just average good finishes, yet experts who know woods have called them mahogany and walnut, even though they are but birch and gum. The name of the wood means little, strength factors being equal; the finish is all the eye ever sees without the aid of a lens, and hence with a good finish, properly designed, all demands are satisfied.

The third statement about an oil-wax finish is the inevitable sign of the good mechanic who knows well how to make things but cannot finish them to the best advantage. Let me try to dispel once and for all the common misinformation regarding the value of the oil-and-wax finish. It simply does not exist. The method is too tedious and too unsatisfactory from the viewpoint of color, clearness of tone, enhancement of natural grain, and heat and water resistance. Oh, yes, I have turned out quite a number of antique pieces to satisfy people similarly misinformed, but almost without an exception the pieces came back to be refinished in a more modern and practical manner.

The last statement to the effect that the underside of the top should be given the same finish as the rest of the piece calls for unnecessary labor. I do not mind working, even working hard, but I do draw the line on doing needless work. Among the many hundreds of antiques that have passed through my shops and have stood up for many years under every possible condition, I have yet to find a top which had any work other than the minimum requirements done on the underside. Let us at least be practical even in the high ideals of Guild craftsmanship.

How then may we know good finishes, you ask? That



1, 2, 3. Black China wall brushes, 3, 4, and 6 in. 4, 5. Ox-hair varnish brushes, 1½ and 4 in. 6. Pure badger varnish brush, 2½ in. 7. Fitch brush for varnish and shellac, 2 in. 8, 9, 10. Oval paintbrushes. 11. Curved handled rubbing brush. 12, 13. Black China paint and varnish brushes. 14, 15. Dusters

Not only must good brushes be bought, but they must also have the best of care. Brush keepers of commercial and homemade types are shown. The bristles should clear the bottom of the cans by at least an inch

is what this series is for—to answer such questions and offer methods and materials adequate to the work in hand.

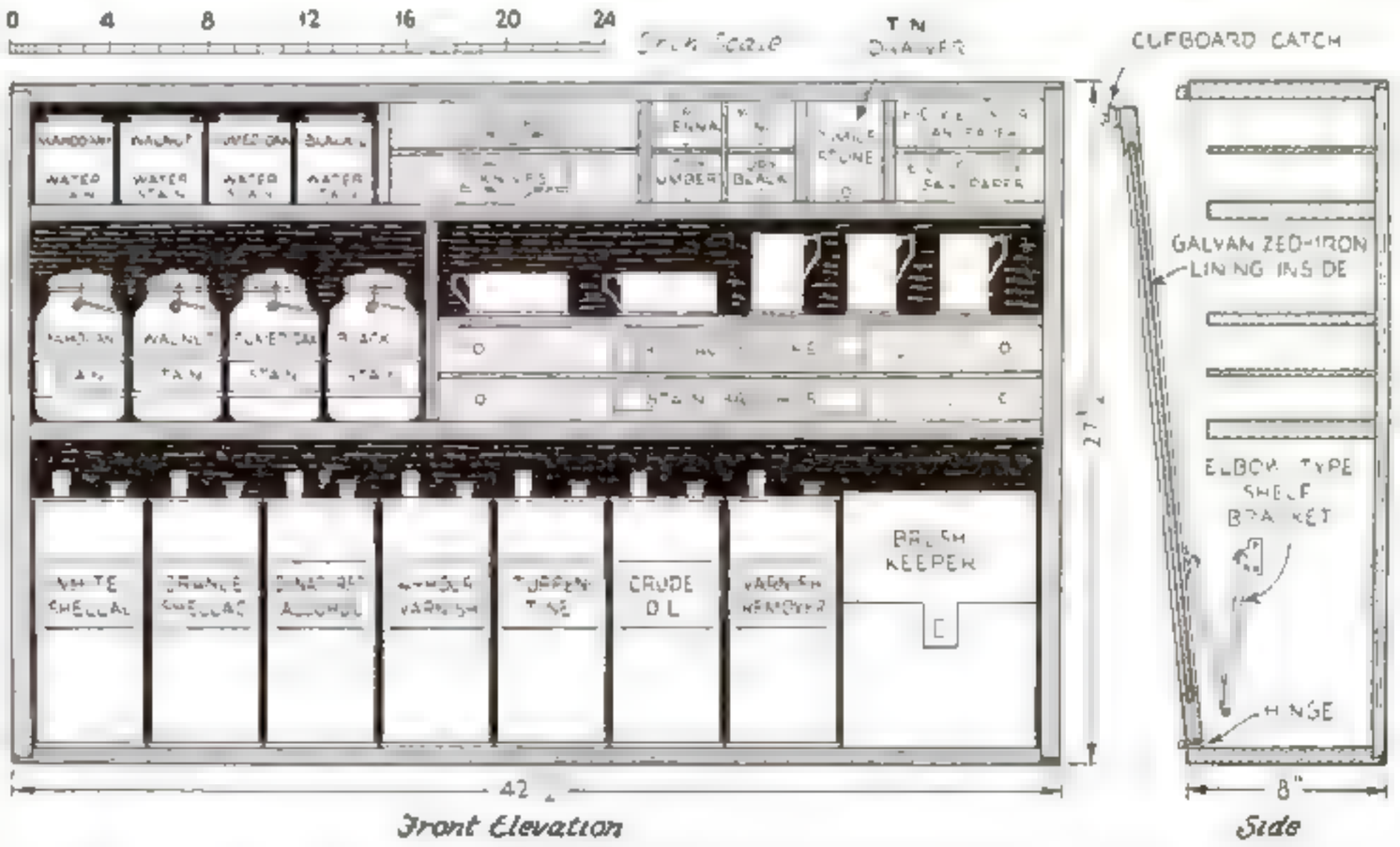
All good things must have a sound and proper foundation. Let us assume, therefore, that your piece of furniture is well designed and well constructed.

The first thing to decide is just the color effect you desire in order that it will harmonize with whatever other pieces it is to be near. Only once in a great while can you have a piece which may be used as a high-light in a room because of its departure from the general tone of walnut or mahogany or maple, as the general finishes are named. Such an unusual piece has, however, been chosen to illustrate the first of this series because it embodies a number of methods and materials which would apply equally well to the standard finishes and woods. Pieces like the small table of American Colonial design shown on another page are assembled complete and trimmed, then taken apart as far as practicable for finishing, when made under home workshop conditions.

Every good mechanic understands the necessity for good tools in turning out a well-made product, and this is equally applicable to finishing. For sanding purposes use a hardwood block cut 1¼ by 3 by 5 in., with the top edges all rounded and the sides coved to fit the fingers. A piece of ¼-in. battleship linoleum should be glued on the bottom to prevent bumping moldings and to afford a certain amount of give to prevent line scratches while using a quarter sheet of paper. Similar blocks of hard rubbing felt cut from 1-in. and ½-in. stock to 3 by 5 and 2 by 3 in. are needed also. For cabinetwork, buy garnet paper, since this will outlast flint paper three to one. You should have Nos. ½, 0, 3/0, and 5/0. Do not discard pieces of 3/0 or 5/0 which have been used on clean wood; they will be useful in sanding finish coats later on.

Study the illustration of the half-sanded table top, which has been recently veneered and dried, then molded on the edge, and is now being cleaned up for finishing. First the whole top is cut down level with No. 0 paper, the linoleum-covered block being used to sand in straight, back-and-forth lines. Avoid any crosswise or circular sanding. A dry floor-scrubbing brush is useful for cleaning off the occasional spots of glaze which will appear on the sandpaper after use. If left, these may cause serious scratches.

Few amateurs inspect their sanding properly, but this is a matter easily remedied after studying the photograph in which the sander has turned his back to the light so that he can see the inadequately sanded portions and mark them with chalk. What cannot be seen can sometimes be readily detected with the finger tips, which are passed lightly but thoroughly over the piece. It is at this stage that real finishing begins, and to omit any of the steps or to do them carelessly is to insure regrets thereafter. Above all, see to it that all sharp edges are rounded slightly—about as much as the round of the lead in an ordinary pencil. Edges so sanded with No. 3/0 paper retain the stain and finish and appear sharper than edges left sharp.



Front Elevation *Side*

A well-equipped home workshop should eventually have a collection of brushes like those shown at the top of the page and a wood-finishing cabinet with approximately the supplies indicated above

At left the table top is being inspected and all improperly sanded portions marked. Note angle at which the top is held in relation to the light. The actual sanding is done with quarter sheets of sandpaper folded over a block as illustrated in the photograph below

Many a fine piece of good furniture has been ruined in use by having its edges wear white.

This particular table has a maple band molding on the edge and a crossband of ripple-figured black walnut surrounding a satinwood center. After the entire piece has been sanded with No. 0 garnet paper, the top is sponged with a clean cloth or sponge dipped in tepid water and wrung out practically dry. This should be used to dampen slightly all parts of the top, which should not be touched by the hands or dark spots will be certain to develop. Whenever the hands touch iron tools and later a damp wood containing tannic acid, as nearly all woods do, a form of ink stain then develops which must be bleached out.

Bleaching, where necessary, is done with any of the commercial solutions used to bleach laundry clothes and can be had at most groceries in bottles. Apply this with a clean floor brush or a rubbing brush; do not use a sponge or it will fall to pieces in your hand. Apply to a whole surface on the part affected rather than to the local spot, which may become enough lighter to be noticeable. All sponging and bleaching operations tend to raise the grain of the wood and lift up any bruises that may not have been seen or dents which may be submerged.

After it is dry, the piece is again sanded clean, true, and glass smooth with No. 3/0 or 5/0garnet paper. Inspect particularly for any traces of cross grain or circular sanding scratches, which, if allowed to remain, are certain to appear beneath the finish. Whenever possible, use some form of pad or old blanket upon the bench top to prevent denting or otherwise damaging the top.

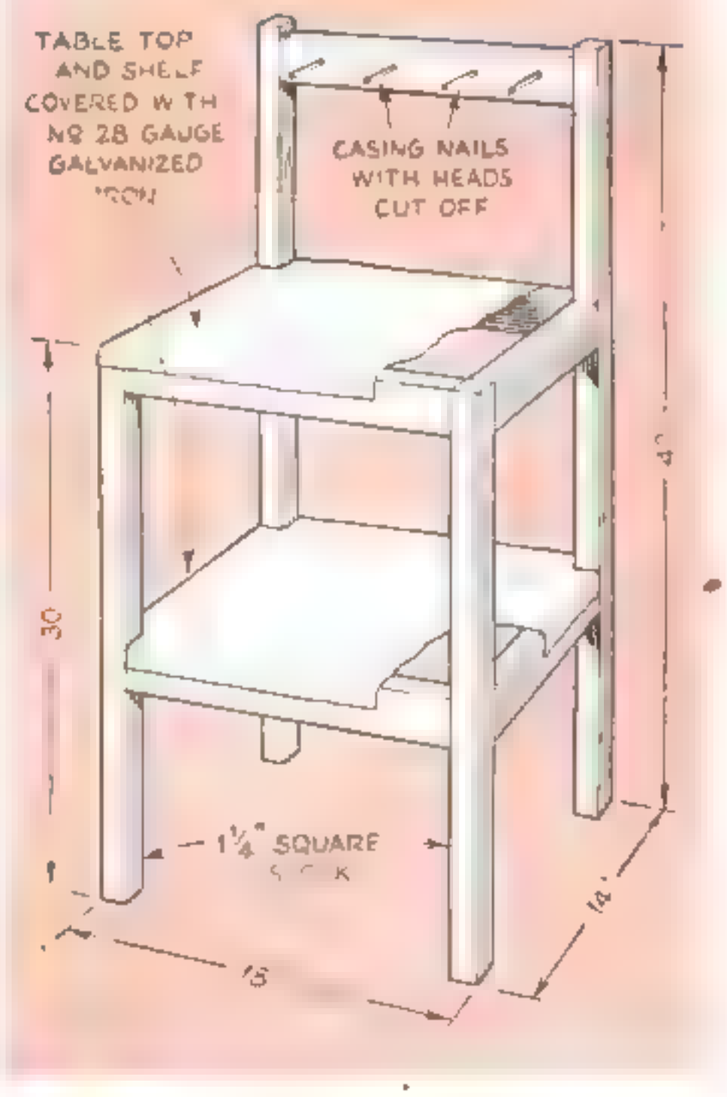
Circular work, as the turned column and band-sawed feet of this table, should be cleaned up with the partly used papers left from the work on the top. Their previous use has made them more flexible and less sharp so that when their backs are slightly moistened, they adhere to the fingers and permit sanding the turned and rounded portions without cutting off bead or fillet details. Sponge, bleach out any spots, dry, and resand as for the top. Be very particular about taking out all traces of glue around the leg joints, since stain will not penetrate glue. Sometimes the only way to remove such traces is to use a rubbing brush and boiling hot water.

Beginning to stain the table. Those parts least seen are always done first, and conspicuous parts last. Note how brush is held

This sponging and resanding process overcomes the only possible objection to the use of water stains, the fact they do raise the grain. This, however, is a matter in their favor on quality work since the raising of the grain opens up the pores, lifts up dents to permit cutting them down to a permanent level, and generally clears up the surface for the production of a fine transparent finish, not at all possible with other stain types. The small amount of time and labor needed for this extra sanding will soon be forgotten when the results are noted on the final inspection.

At this point a short discussion of the various stains is in order. Those which use pigments ground in oil and thinned with turpentine are not stains in any sense of the word, though often offered for this purpose. They are merely dilute paints and cannot be expected to give any but the coarsest of effects. Stain powders soluble in alcohol, while easy to make, are difficult to apply without innumerable streaks and patches; are easily lifted by subsequent finish materials, and worst of all, fade almost eighty percent. The so-called "penetrating stains" are not at all satisfactory, since it is difficult to reduce them for making lighter colors; they streak and lift badly when coated with shellac; they may even bleed through a number of coats; and, like the spirit stains, they fade about fifty-seven percent.

Water stains, on the other hand, overcome all these objections and at the present time can be purchased from various stain manufacturers in standard colors of standard concentration. Practically all woods can be stained and all the various shades matched readily if standard 4-oz. solutions of red, yellow, orange, and black are kept in gallon jugs ready for use. Stain powders of standard colors also can be bought by the pound or less, and 4 oz. of the dry color are dissolved in a gallon of hot water. This can be kept in a glass container and used as needed, so that the color will always be on hand for a future match on another new piece of furniture. The investment is small and the stain does not deteriorate under average storage conditions. It is even possible to use high-grade household package dyes of the type sold for dyeing silk. Get them in the colors named above and make up the solutions for your own match colors. For this it will be necessary *(Continued on page 85)*



This light, convenient paint-shop stand is a genuine labor saver and well worth making

JACK HAZZARD, famous canoeist, tells how to

Deck Your Sailing Canoe

SO THAT IT WON'T SHIP WATER

To CANOEISTS, Jack Hazzard needs no introduction. The deck he describes is one he placed on his canvas-covered canoe before sailing it in the last President's Cup Regatta in Washington, D. C. It saved him from having to carry an extra weight of water through the finish of every race.

CONTRARY to general belief, the garden variety of canvas canoe makes a fast and sporty sailer if crowded with sufficient sail. Its chief handicap is its sharp build and the fact that, when driven beyond its designed speed, it dives through rather than over waves, shipping water in uncomfortable quantities.

For occasional sailing it is probably wise to rig snap buttons, or hooks and a tightening lacing, but for regular sailing on open water a semipermanent deck is more efficient and can be made so shipshape as actually to improve the general appearance of the canoe. Since space is at a premium, it is best to make a full deck forward with coamings and narrow decks along the waist. The center of the deck is raised in a ridge to improve the appearance.

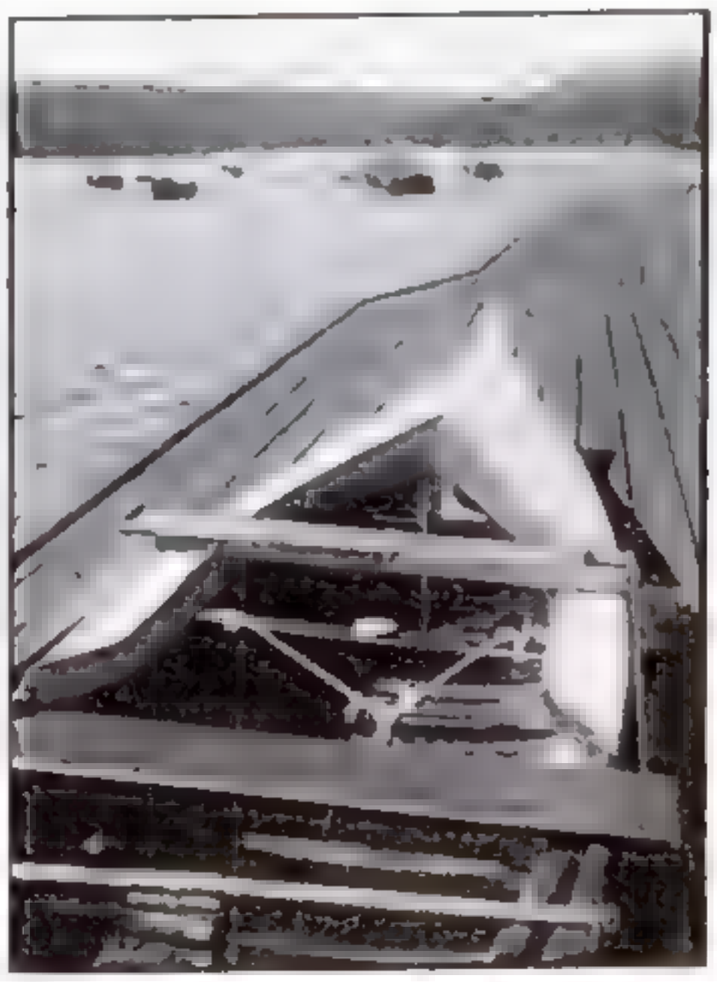
As canoes vary in sheer-line profile, the same deck curve would not be sightly on all types. To build up a suitable curve for the deck stringer, clamp a block to the after side of the forward seat, and to this block clamp an upright. Fasten a limber batten to the upright with another clamp, and run the batten forward, its end resting on the forward breasthook. With string and weights, bend the batten downward to a fair curve. Keeping the eyes level with the wale, view the curve from a distance and adjust the weights until it looks well.

Once you have a sweet curve sweeping back from the breasthook to the upright, place a large cardboard perpendicularly against the batten and mark the line clearly, thus forming a pattern for the upper edge of the deck stringer, or ridge. It may be cut from thin spruce or other light, strong wood, but three-ply 3/16- or ¼-in. fir is probably the best material. It should match the breasthook in depth at the bow and should increase in size gradually to about 1¼ in. where the coaming joins. There should be a thin piece of the stringer running right up the middle of the breasthook to the stem head, thus carrying the ridged effect throughout, which is necessary for good looks.

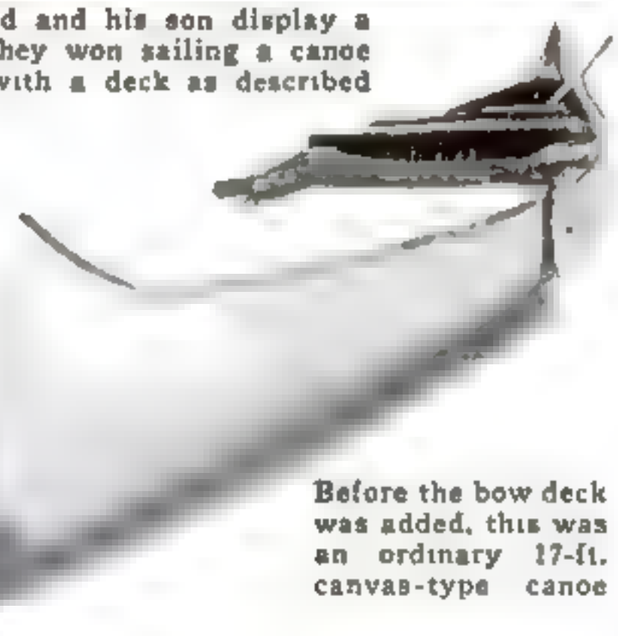
With the stringer cut and the height at the peak of the cockpit established, cut and fit a brace of ⅞-in. white pine to bolt to the seat in place of the clamped upright and block, slotting it to fit the lower edge of the stringer. The stringer will project aft of the supporting piece to a point over the center of the forward thwart and should not fit into the slot the full width.

Diamond-shaped frames must now be made as shown to fit the curve of the inner side of the wales, ranging 9 or 10 in. forward and 12 to 13 in. aft the end of the stringer and *(Continued on page 109)*

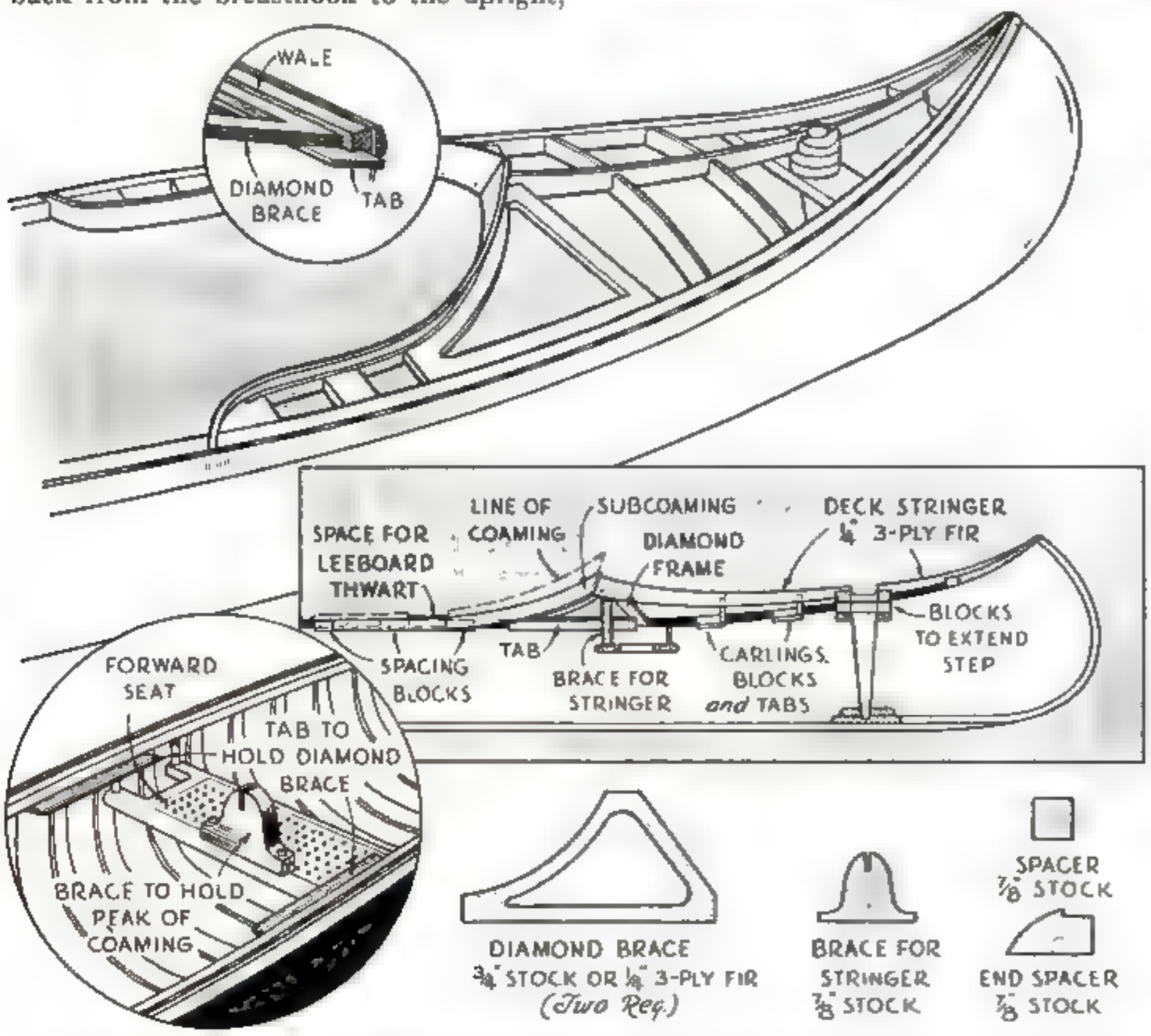
Hazzard and his son display a prize they won sailing a canoe fitted with a deck as described



View showing the curved coamings, which project above the deck and turn back any water



Before the bow deck was added, this was an ordinary 17-ft. canvas-type canoe



Diagrams showing the general method of installing a full deck forward and narrow decks along the waist. The actual construction has to be of the cut-and-fit type because canoes vary so much

Heavy-Duty Woodworking Vise

Runs Smoothly on Guides

MADE FROM PIPE

The homemade vise in use. Note its large capacity and how the jaw remains rigidly parallel to the edge of the thick bench top. If desired, a stationary jaw may be added

By REGINALD O. LISSAMAN

List of Materials

1 iron bench screw, size 1¼ in., with square thread for approximately 12 in. of its length.
2 pc. pipe, 1 in. inside diameter and 20 in. long, threaded at one end of each.
2 pipe flanges to fit above.
1 pc. oak or maple 1⅝ by 12 by 10 in. for front jaw.
1 pc. oak or maple 1⅝ by 4 by 12 in. for jaw batten.
6 carriage bolts 4 by 5/16 in., to be used in front jaw.
2 pc. pipe, 1¼ in. inside diameter and 12 in. long, for guide sleeves.
4 lag screws 5 by 5/16 in. for sleeve assembly.
2 pc. 2½ by 2½ by 12 in. hardwood for cross members of sleeve assembly.

MANY woodworking vises of home construction are inefficient. This is due, in the main, to their ill-devised guides, or to their complete want of them.

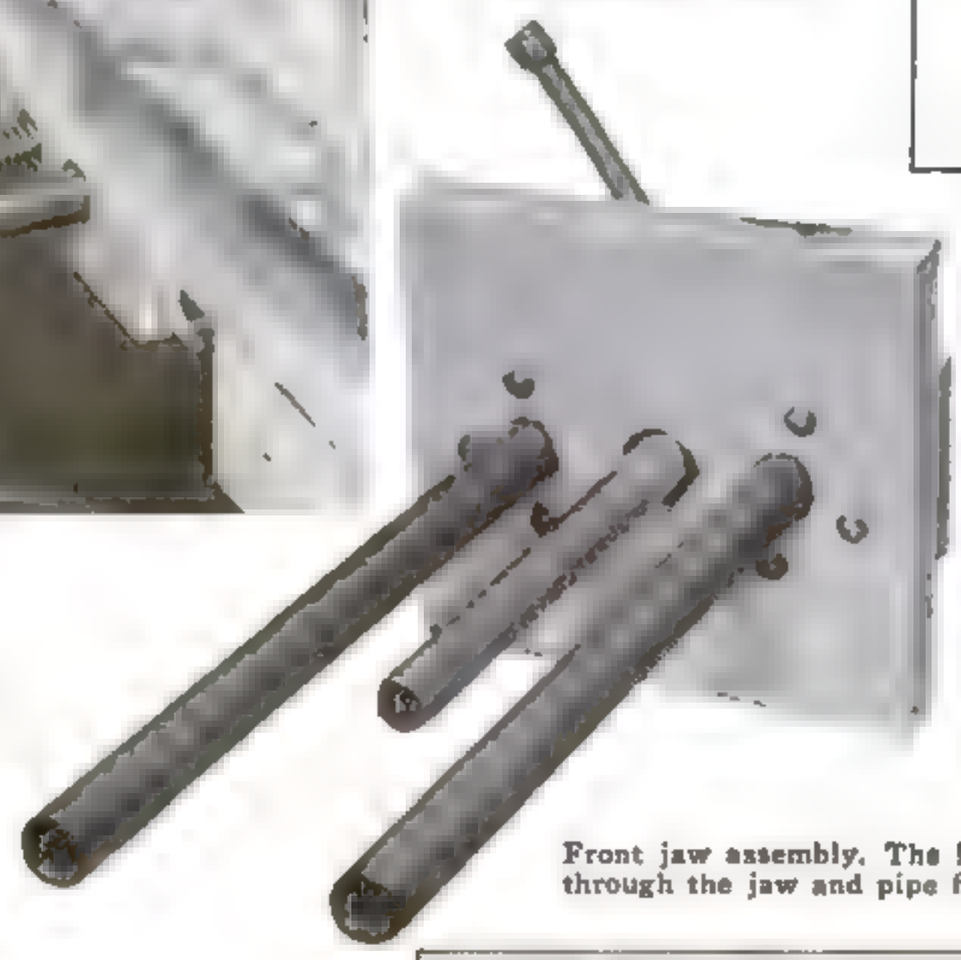
In the vise illustrated, two sizes of ordinary plumbing pipe are used to form a guide system that is extremely rigid, yet free working No machining is necessary provided the plumber, after he cuts your pipe, threads one end each of two pieces. The jaws open to approximately 9 in. and provide a working depth of about 4 in. Light metal and sheet-metal work may be done by temporarily laying a piece of angle iron over each jaw. The vise can be made at a cost of about three dollars for materials.

Hardwood should be used in the construction. The illustrations show fir serving as the front jaw of the original model, but this will be replaced when necessary with oak or maple. The grain of the wood in the jaw should run vertically.

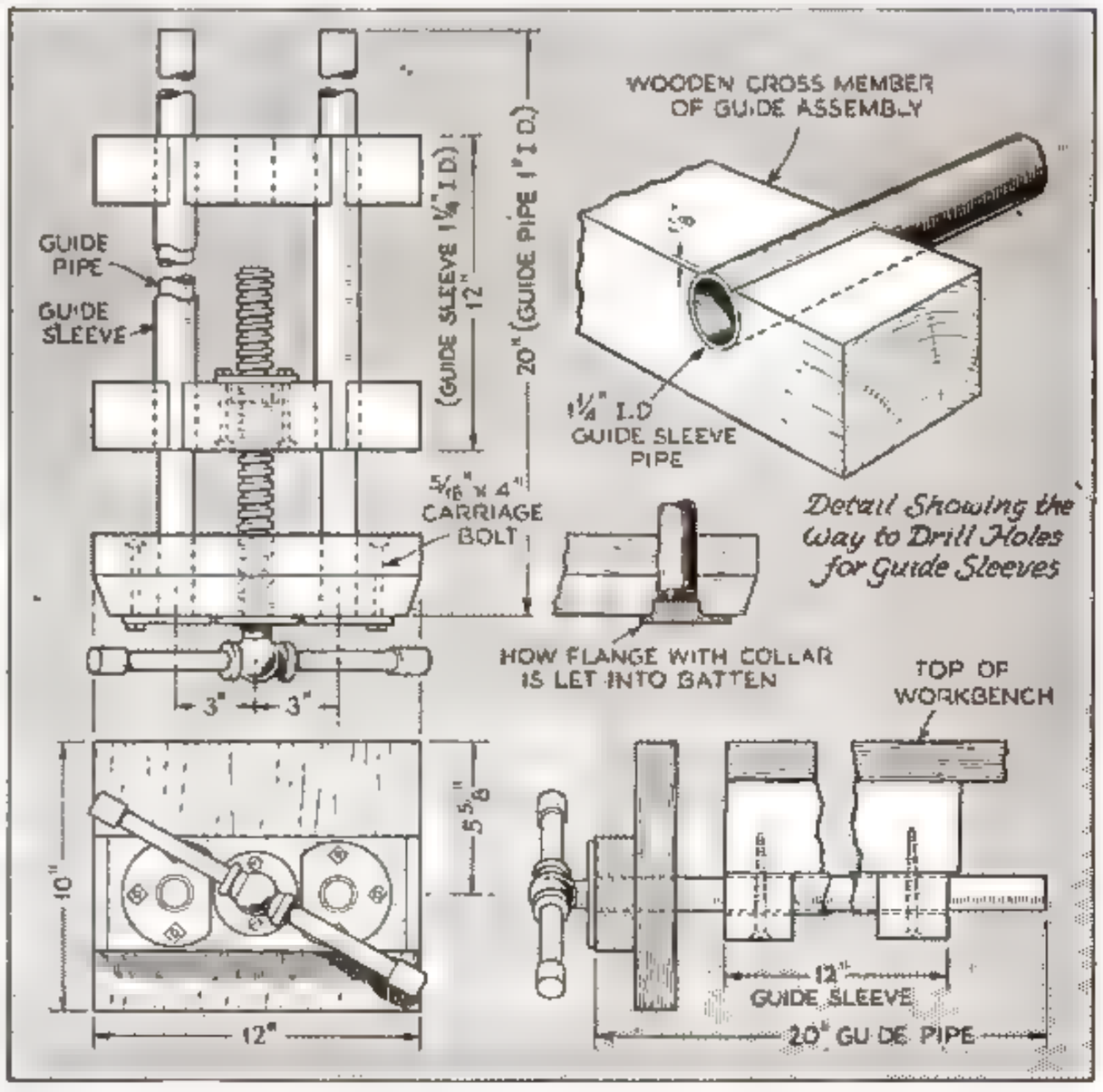
After cutting the jaw and the reenforcing batten, fasten them temporarily together (bolts will later hold them securely); then mark the centers for the two guide-pipe holes and the bench-screw hole. The former should be drilled for a snug fit; the latter, large enough to allow the bench screw to work freely.

The two pipe flanges require a segment to be hacksawed out as shown in the drawing. After this has been done, they are each turned tightly on the threaded ends of the guide pipes. Should the flanges have a collar around the threaded hole, place them so that the collar will have to be let into the batten in order to keep as much hand room between the vise handle and the jaw as you can. Mark the location of the holes in the flanges on the batten and drill through batten and jaw for the carriage bolts. Countersink the boltheads on the inner side of the jaw; and after tightening the nuts well, cut the bolts off flush with the nuts. This completes the front jaw assembly except for putting the bench screw in place and fastening it with two wood screws, but this is better left to the last in order to simplify aligning the various parts.

The guide-sleeve assembly, which is fastened to the underside of the bench, offers no difficulty other than demanding accuracy in its making. The holes for the guide sleeves in the two cross members must be carefully located and drilled. These holes may either be bored close to the edge and then the top edge dressed down, or drilled so *(Continued on page 100)*



Front jaw assembly. The heads of the bolts which pass through the jaw and pipe flanges are sunk into the wood



The guide assembly, when completed, is bolted to the underside of the bench, and the vise-screw nut is let into the back of the first wooden cross member

A NEW STUNT FOR WHITTLERS...

Cutting a Pocketknife

from One Piece of Wood

By E. J. TANGERMAN

The handle and blades of the wooden knife are made in a single piece, and pivot joints are cut just like real ones

IT IS common enough to whittle with a pocketknife, but to turn around and whittle a pocketknife with a pocketknife is a bit of a paradox. It can be done, however, and the knife, although cut from a single piece of wood, can have blades that open and close just like a real one. The idea is simple enough, requiring only a sharp knife and a steady hand. The trick lies in making the knife with its blades open and closing them afterwards.

Make a copy of your own pet pocketknife, or one like mine. Let's assume it's mine you're making. Lay out on a 3/16-in. piece of very straight-grained white pine or basswood ¾ by 6½ in., a checkerboard of ¼-in. squares similar to Fig. 1. Copy the outline and saw or whittle out the blank (Fig. 2). Thin down the blades until an end looks like Fig. 3.

Next cut out the inside of the handle, first outlining all around as in Fig. 4, then splitting out little wedges of wood. As you get deep into the handle, you will have to cut diagonally at the butt of each wooden blade (Fig. 5). A series of criss-cross cuts at the bottom of the hollow will also help you to "chew" out the wood down to the required 1/16 in. from the back, as in Fig. 6. Gage the depth constantly as you work by measuring with the tip of your knife blade.

Now comes the careful part—rounding the blade pivots and releasing the blades. Begin as in Fig. 7 by cutting around the pivot with the knife tip, cutting out a little V all around the pivot, as shown in one of the photographs. Work very slowly and carefully, cutting always with the grain, as in Fig. 8, because the wood of the pivot is across grain, hence fairly weak. Cut down until the pin stands out free to a depth of slightly over 1/16 in. (the thickness of one side of the handle). Cut a V out around the pivot on the other side in exactly the same way, making very sure that the two sides of the pivot are exactly in line, just as they would be if a hole were drilled straight through and a dowel rod put in.

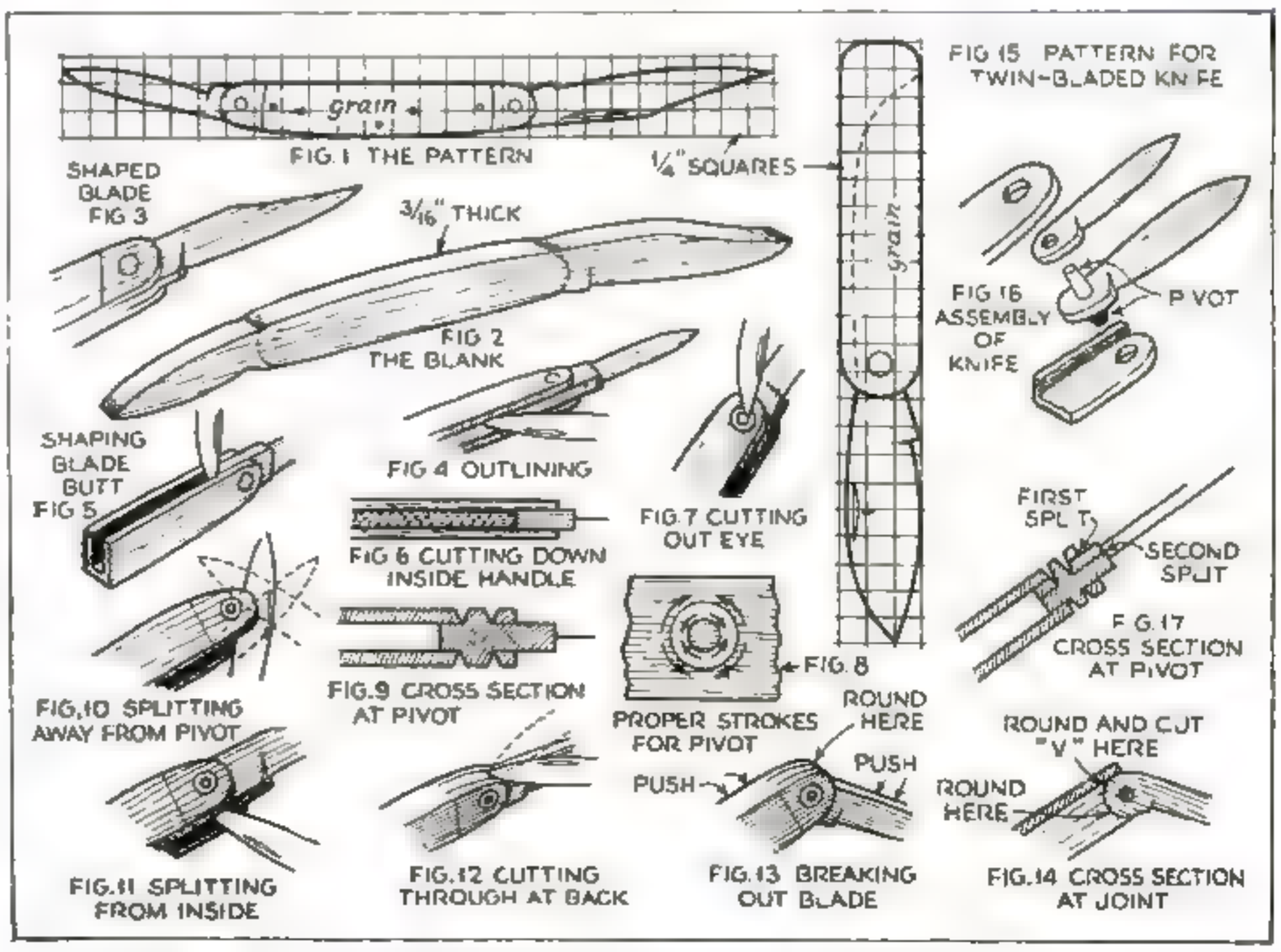
Now lay your knife blade along the butt of the wooden blade, and gradually work it in toward the pivot from all sides, using a rocking motion. Work in just to the pin, as in Fig. 10, until you see the edge of the blade at the base of the V around the pivot at all points. Work from the inside as in Fig. 11. This frees the blade and pivot except for the joint at the back.

If you will examine your own knife, you'll see that there is a little leaf spring which forms the back of the knife and also holds the blade tightly in the half open or fully open position. You can simulate this spring and its effect by cutting along the back a little, as in Fig. 12. Now work the tip of your knife blade in along the back of the wooden blade, rocking it slightly to cut the full width of the "spring" section until you can see the tip of the blade inside the wooden-knife handle. Cutting and rounding out at the heel of the butt may help you get through more quickly, as indicated in Fig. 14 (top). This part of the work may go more easily and with less danger of splitting if you soak the piece thoroughly first.

Try the wooden blade gingerly to see if it is free. If not, you may be able to cut away a little wood here and there to loosen it. Take hold of the wooden-knife handle in your left hand and the blade in the tips of your right-hand fingers, just as you would to close a real knife, and slowly, carefully start to close the blade, meanwhile keeping a steady pressure *toward* the pivot, as in Fig. 13. Your heart may jump into your mouth when the blade comes free, because there is almost always a little tongue of wood uncut somewhere around the blade, but if you have been careful, the blade will come free without snapping the pivots. A little rounding up, as indicated in Fig. 14, and smoothing at the sides of the blade butt, will help the action. Then cut in the thumb-nail notch, smooth it up, and that end of the knife, at least, is finished. Make the other end in exactly the same way.

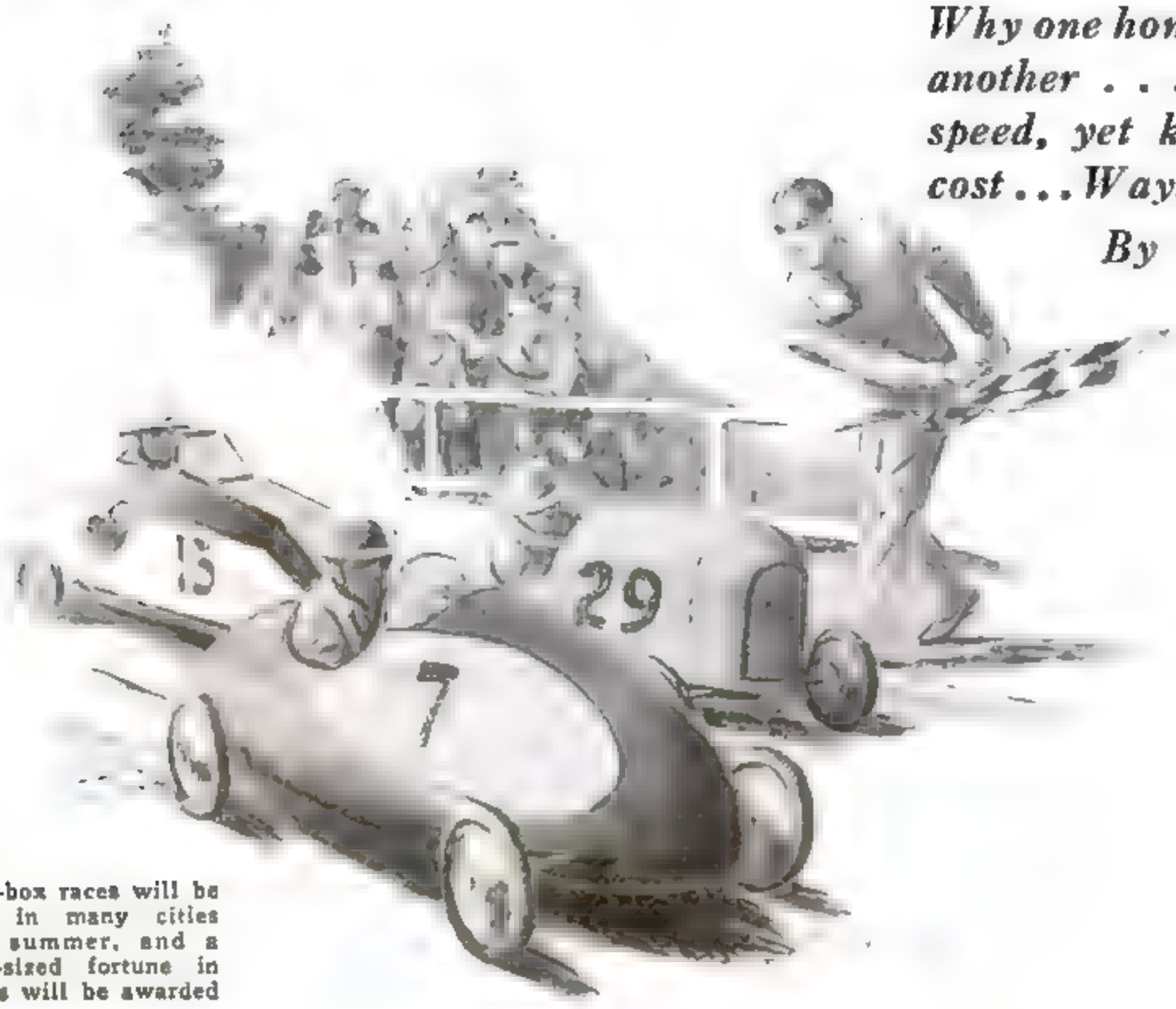
Now try to close the blades into the handle. If they are too thick, thin them down a little, or if the butts are binding, shave them off. The knife can be made to close just as naturally as a real one. Now round and smooth up the handle, put on the markings, and your wooden knife is finished.

It is also possible to make two blades on one pivot—in fact, one of the photographs shows a knife made that way. This particular knife is of redwood, but I recommend white pine or basswood—they're not so likely to split and crack. The assembly sketch, *(Continued on page 90)*



These drawings shows the various steps and also how two blades can be made at one end

HERE ARE THE Answers to Your



Soap-box races will be held in many cities this summer, and a good-sized fortune in prizes will be awarded

Why one home-built coaster is faster than another . . . How to insure maximum speed, yet keep down the construction cost . . . Ways to test a car and other hints

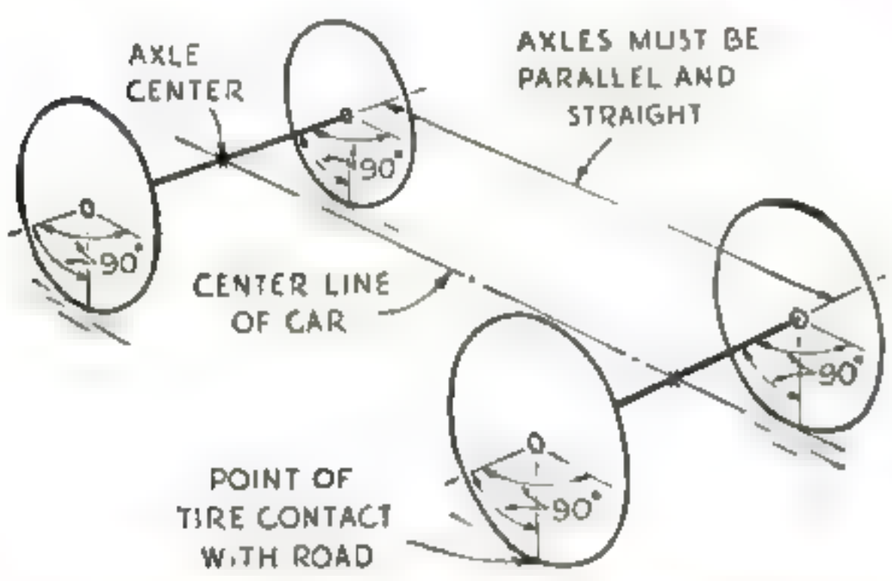
By **PHILIP R. TARR**

ORDINARILY you wouldn't think that science has much to do with soap-box racing, yet it has. Unless you are well acquainted with the scientific aspects of this form of sport, you will find it difficult to construct a car which is capable of winning any of the numerous local contests that are to be held this summer, not to speak of the national finals in Akron, Ohio, for the all-American championship.

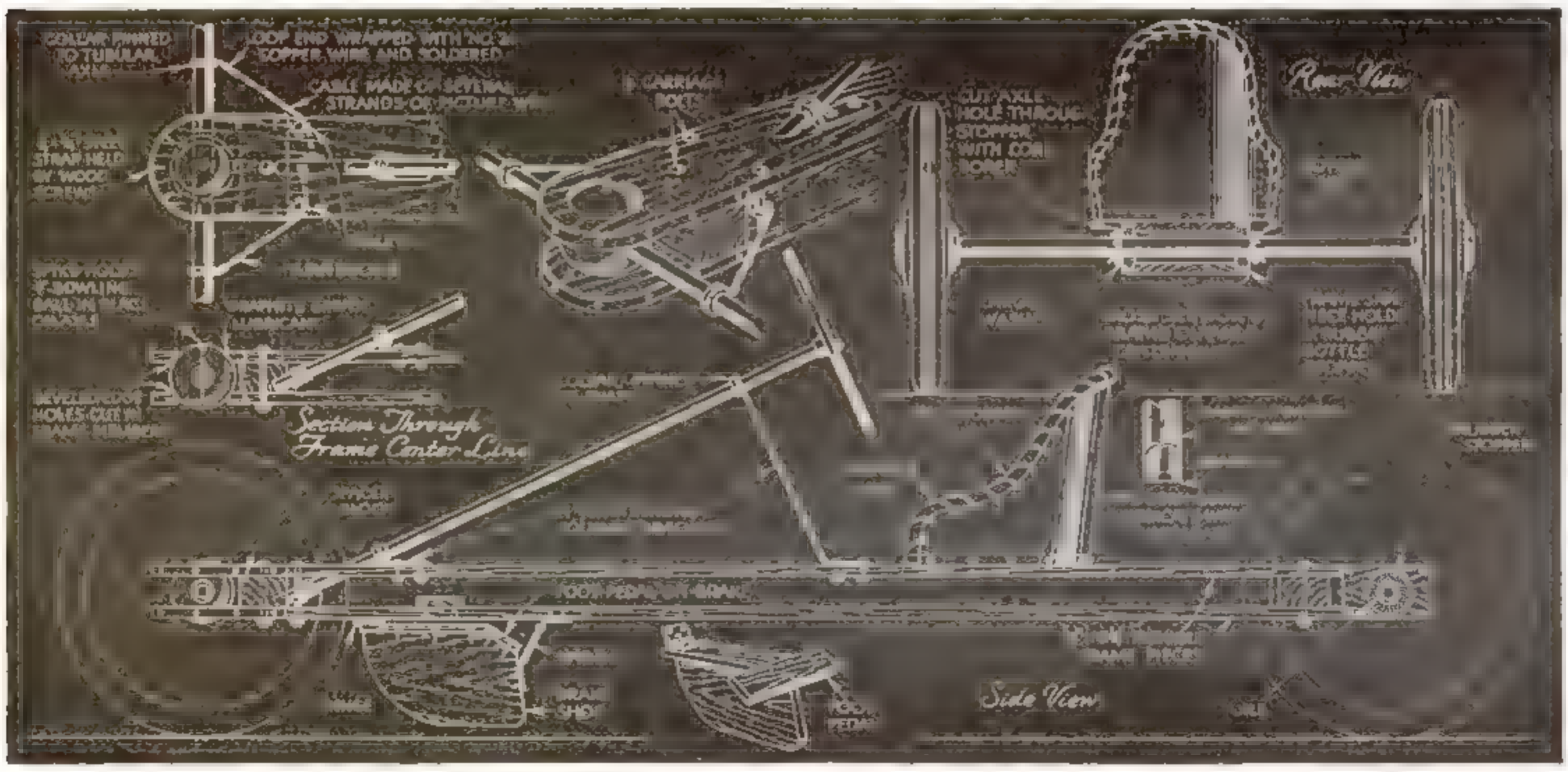
No large sum of money is required to build a first-class car, neither is any genius. What it really takes is a thorough understanding of conditions that confront the builder and driver.

Much information has been published about these little cars, but a great many questions still remain unanswered. Some of these questions are far more difficult to answer than anyone but a specialist is likely to realize. Then, too, there is always room for honest differences of opinion. Replies to some of the more important questions will be given, based on many tests on the race course and in the laboratory. While the answers represent the author's better judgment, they are not intended to influence those who have other and perhaps superior ideas and theories. After all, the final test lies in the split second by which the best car wins. If you can build and drive that winning car, you need no technical advice.

1. What are the factors that directly influence speed in soap-box racing? There are many—tire design, weight, bearing design, tire inflation pressure, rolling resistance, for example. All are important, not only individually, but in the many combinations they form. When planning and building a racer, keep this in mind: Given two cars mechanically alike in every respect except one, and driven alike, *that one difference will decide which is*



Wheels must be parallel and at right angles to the road

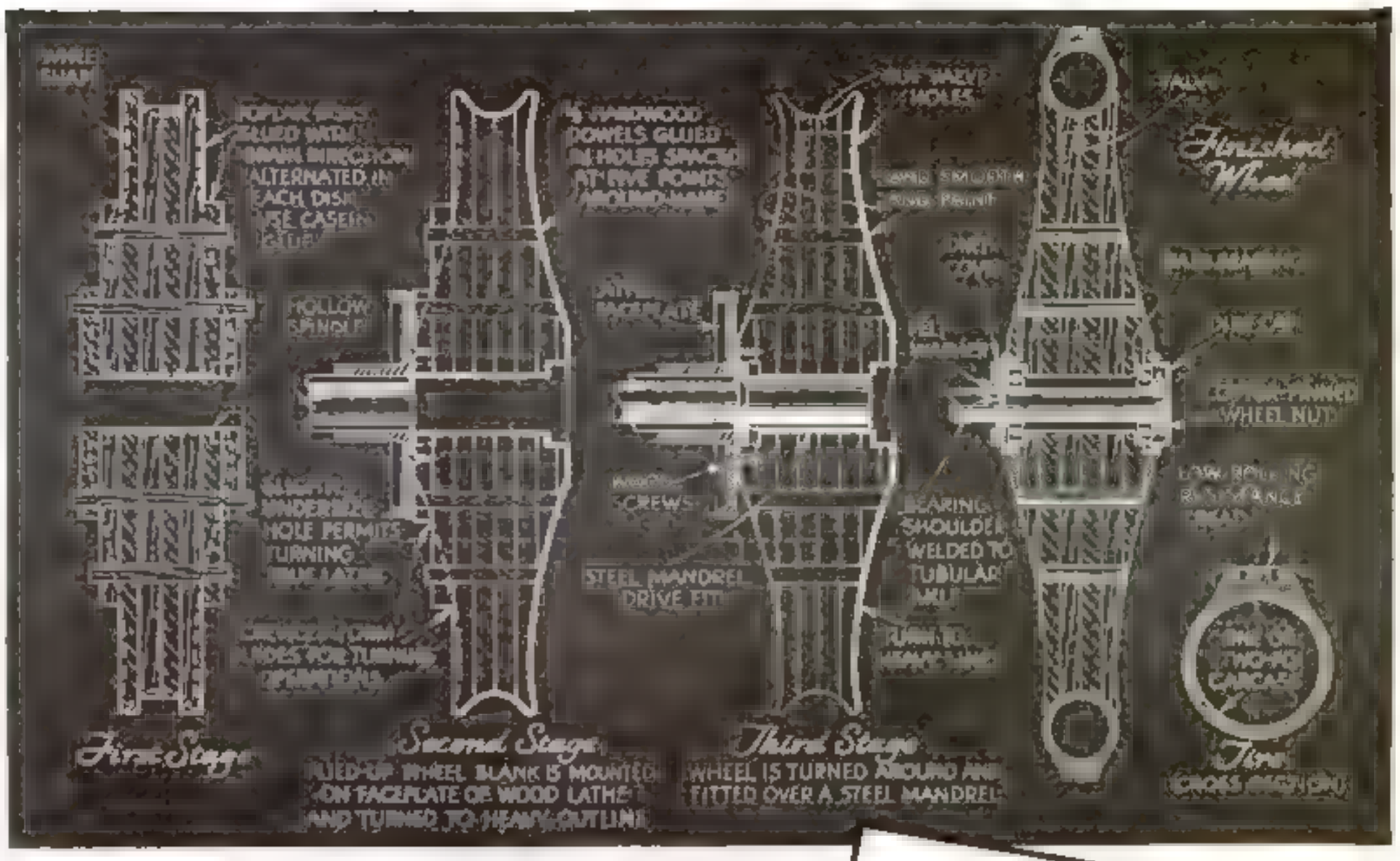


Soap-Box Racer Questions

the winner. Your chance of winning depends directly upon how thorough you have been in lowering all frictional forces which might make your car slow.

2. Is weight important? It is. Reference to an elementary textbook of physics would lead you to believe otherwise, but the wide difference between theoretical and actual conditions makes weight one of the most important elements for the following reasons:

Wind resistance. Contrary to opinion, wind resistance is not negligible in soap-box racing. While it is true that these little cars do not average thirty or forty miles per hour, nevertheless they do attain such speeds long before they cross the goal line. Under these conditions a heavier car will have gained greater momentum with which to overcome wind resistance as it approaches the goal and likewise will have greater momentum with which to overcome other frictional resistance at all times Other reactions favorable to weight will be explained later in this article



Soap-box racers usually have commercial wheels, but it is possible to make excellent disk wheels at a reasonable cost by gluing together disks of wood and turning them to shape

Rolling resistance. This is the resistance of tires and bearings to motion It is practically impossible to have two cars in which the rolling resistance of each is exactly proportional to its weight. If this were possible, then we might believe that weight was unimportant. The variables are too numerous to list here, but we might mention tire hardness, tire tread design, bearing friction, the relation of wheel diameter to bearing friction the effects of road surface on different cars, and weight distribution

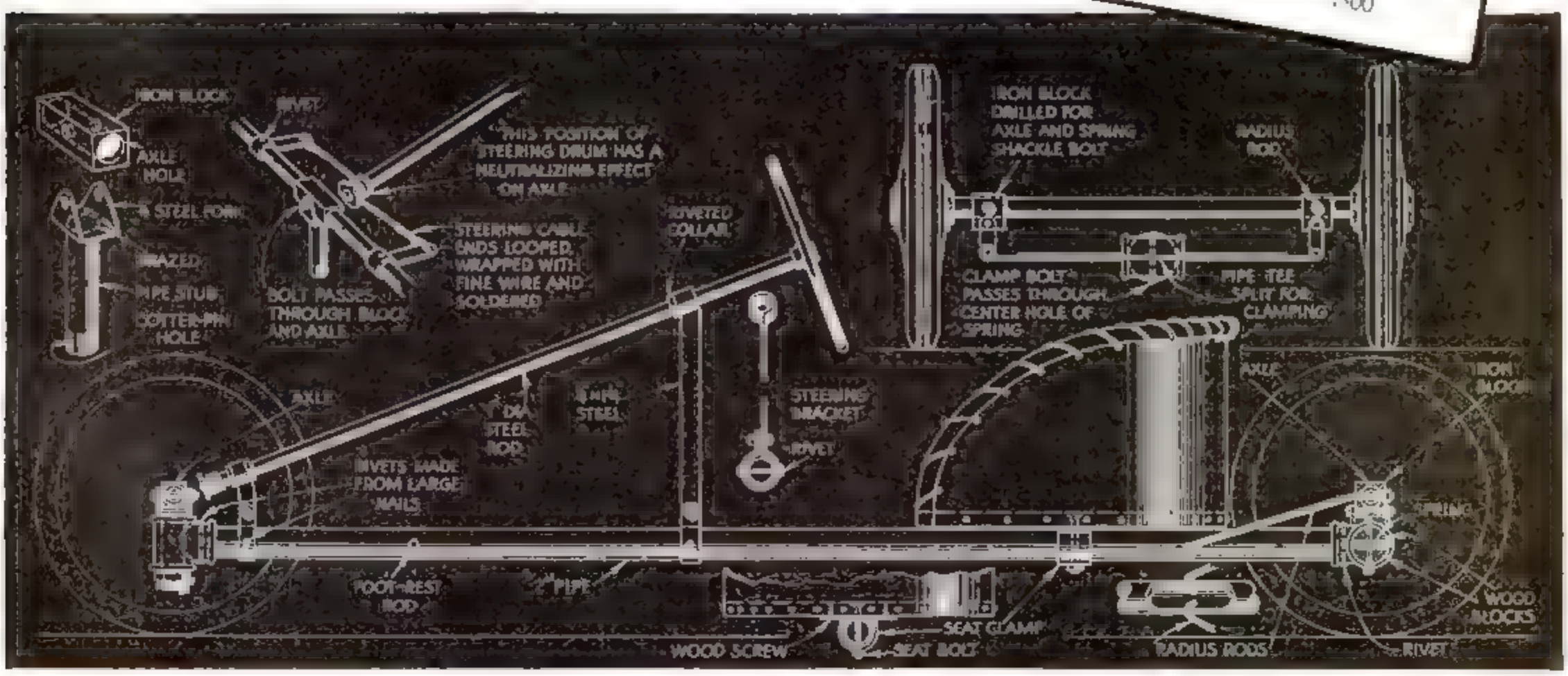
Changing inclination of the grade. Where the grade changes its steepness the heavier car will again have an advantage because, other things being equal, a heavier car will slow down less quickly when the grade becomes less and will gain speed more rapidly when it passes from a lesser grade to a steeper grade.

Last year, prior to the main race at Akron and during some tests, one car was found which could be made to vary its time over the race course several seconds either way simply by increasing or decreasing weight. A case will be explained where increasing the weight might make a car slower, although when that happens you can rest assured that something is radically wrong in the bearing system. When increased weight makes the car (Continued on page 106)

EFFECT OF TIRE INFLATION

Rolling resistance of 30 by 3½ tires and wheels as influenced by inflation pressure when carrying a 600 lb. load

INFLATION PRESSURE (Lb. per sq. in.)	ROLLING RESISTANCE (Lb.)
20	1,200
25	950
30	810
40	740
45	660
50	620
55	590
60	560
65	540
70	530
75	520
80	515
	500



Design for a safe and comparatively simple pipe-framed racer. On the facing page is a similar car with wooden framework. Both include substantially all the desirable features mentioned in Mr. Tarr's replies to questions. In the wooden racer, a small bowling ball is used as a swivel for the front axle. This provides rigidity, yet allows the axle to move in all directions, and also introduces just the right amount of friction for steering

Anyone Can Assemble These Curious

Clipper-Ship Barometers

By EDWIN M. LOVE

A weather balance made from two test tubes and a small diameter tube of brass. At the right is an ornamental corner bracket which holds a clipper-ship barometer. Drawings for both these types are given below

IN THE meteorological instrument section of many large department stores, you will find hanging on the wall a row of curious glass objects with gracefully curved, upturned spouts, all filled with a colored liquid. These are modern replicas of that picturesque weather-forecasting device known as the "clipper-ship barometer." They are now sold chiefly as decorations, but the changing level of the liquid does indicate in an approximate way the same variations in air pressure shown more accurately by a mercury barometer (P.S.M., Apr. '35, p. 64).

The clipper-ship barometer is such a simple device that anyone can assemble one in about five minutes. Besides, it can be set up anywhere, is portable, and requires no careful adjusting.

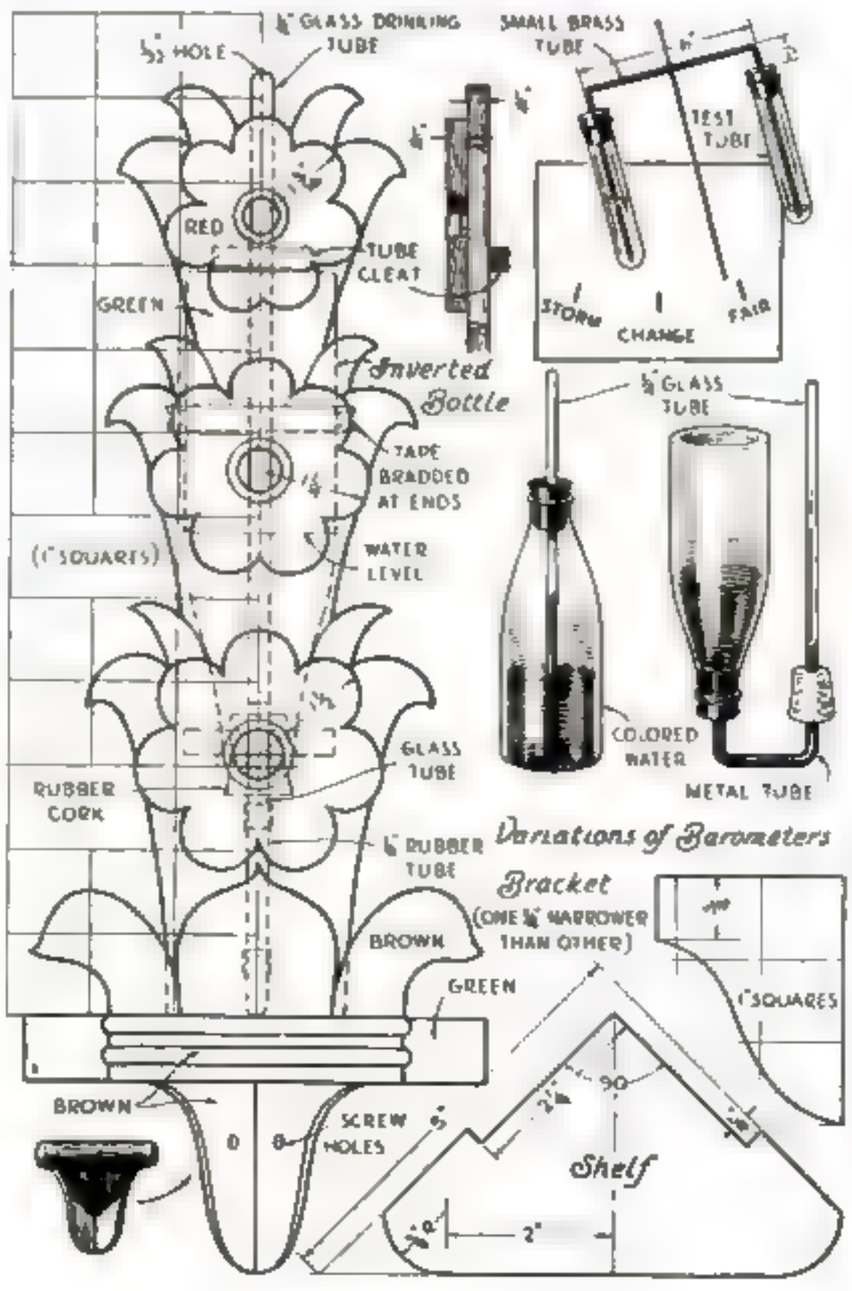
The materials needed are a bottle, a rubber cork to fit, a glass drinking tube about ¼ in. in diameter, and water, preferably tinted with a few drops of ink or other coloring matter to make it more easily seen. Bore a hole in the cork for the glass tube, and push the tube in far enough that it will be within ½ in. of the bottom of the bottle when the cork is thrust into the neck. Fill the bottle about one third full of the colored water.

When the cork is replaced, it crowds the air in the bottle, slightly compressing it, with the result that water is forced to rise in the tube, and thus the instrument is put into service. The water rises until the atmospheric pressure on it, plus the height of the water column, balances the air pressure in the bottle. If a storm is approaching, the atmospheric pressure lessens, causing the water to rise higher in the tube.

Unfortunately, a rise in temperature also expands the air in the bottle and lifts the tube column. To prove this, grasp the bottle above the water with the hand, and watch the surprisingly rapid rise of liquid in the tube. During the summer my barometer, standing in a bedroom in the southwest corner of the house, shows an empty tube at 6 A.M., but in the afternoon, when the temperature is uncomfortably high, a column of water 6 in. high.

Thus the clipper-ship barometer is both barometer and thermometer, and it is not always easy to tell which. If you have a corner in the house where the temperature is fairly constant—in the cellar, for instance—the barometer will show the fluctuations of atmospheric pressure quite accurately, and you can rely on it to forecast local storms, especially if you take note of the wind directions (see P.S.M., July '35, p. 61).

An interesting variation of this instrument is the weather balance illustrated. In this, a test tube substitutes for the bottle, and a small brass tube for the glass one. The tube is bent and the other end is inserted in a second test tube to which air is admitted by a groove cut in the side of the cork. Hang the assembly from a thread tied midway between the glass tubes. When the water rises in the brass tube, it spills into the second test tube, and this transfer of weight from one to the other naturally shifts the balance. If a broom straw is added for a pointer, with the positions of the tip marked for fair weather, foul, and change, a more or less reliable weather *(Continued on page 117)*



Rear view of corner bracket with barometer ready for use. The bottle is held in place by means of two strips of tape

Ball-Bearing REELS

FOR KITE FLYING OR TROLLING

The completed reel is held on the central bolt with a wing nut. Note the small wooden handle

Roller-skate wheels and aluminum pie plates used in making line holders of large capacity

By HOWARD R. HEYDORF

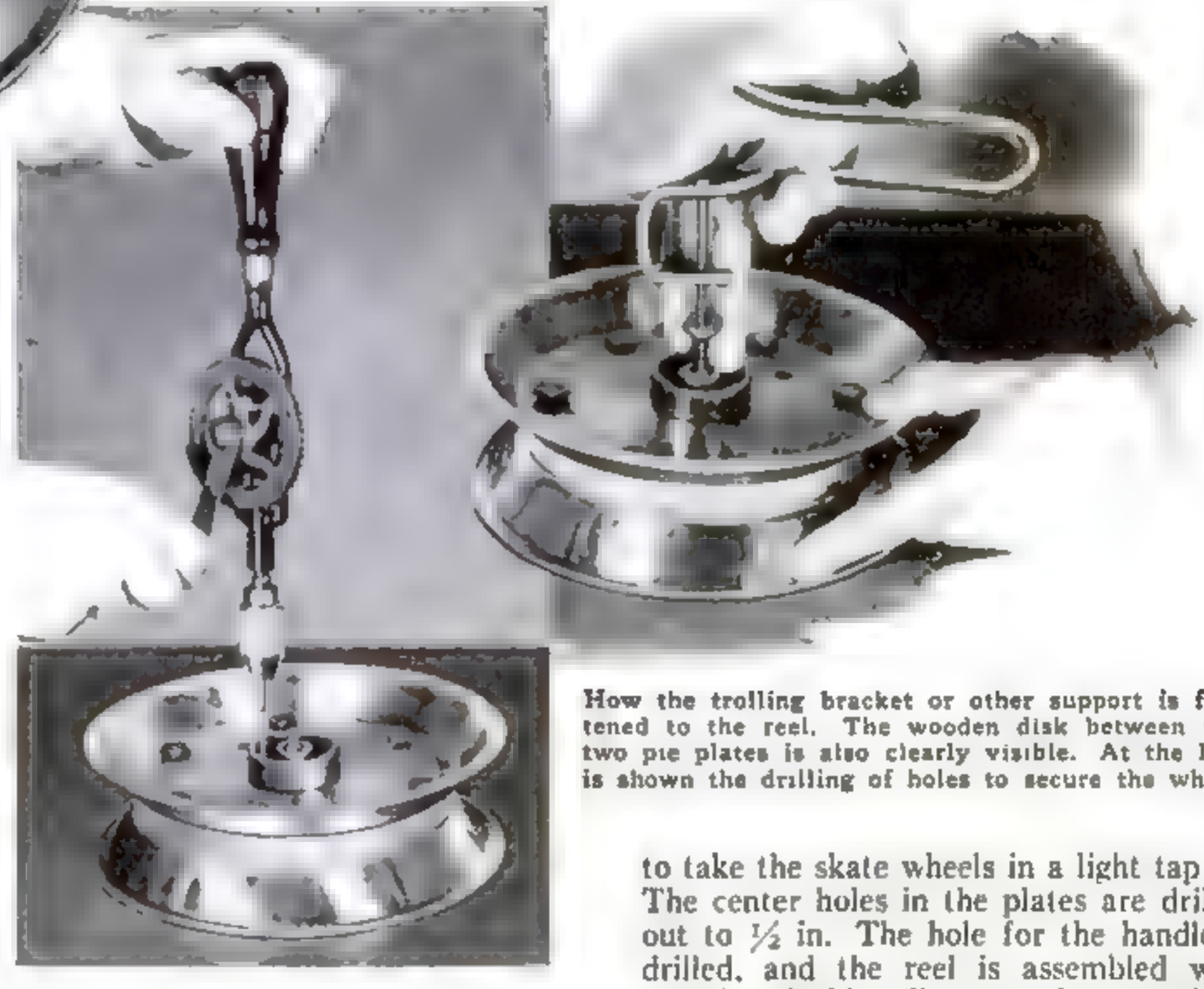
THREE ever-present problems confront the person who wishes to construct a reel, whether for use in flying a kite or trolling without a pole from an open boat. They are large capacity for holding line, quick take-up, and freedom from excess bearing friction when there is a strain on the line. While reels that meet these requirements may be purchased, they are expensive.

The two sturdy homemade reels illustrated are of large capacity and neat appearance. They will take up about a foot of line at each revolution, and the skate-wheel ball bearings eliminate friction.

The construction of the reels is simple, and the materials are readily obtained in any locality. Ordinary aluminium pie plates of about the 8-in. size are used. Tin plates should not be used as they are too flimsy and rust quickly. The center of each plate is found, and the positions of the six bolts are laid out on one of the plates. Though the size of the center hole in most ball-bearing skate wheels is ¼ in., there may be some variation. It will be assumed, however, that the standard size is being used, and this requires that a ¼-in. hole be drilled in the center of each plate.

In the smaller size reel, the plates may be bolted directly together, but the line capacity and the strength are greatly increased if a ½-in. disk is turned and drilled with a center hole to be inserted between the two plates.

In the larger reel two disks ¾ in. thick are turned to fit the plates and drilled with center holes. The plates and disks are placed together and secured with a ¼-in. bolt through the center hole. Holes for the six 5/16-in. bolts are then drilled through the assembled disks and plates. It is advisable to mark the plates and disks for reassembly in the same positions.

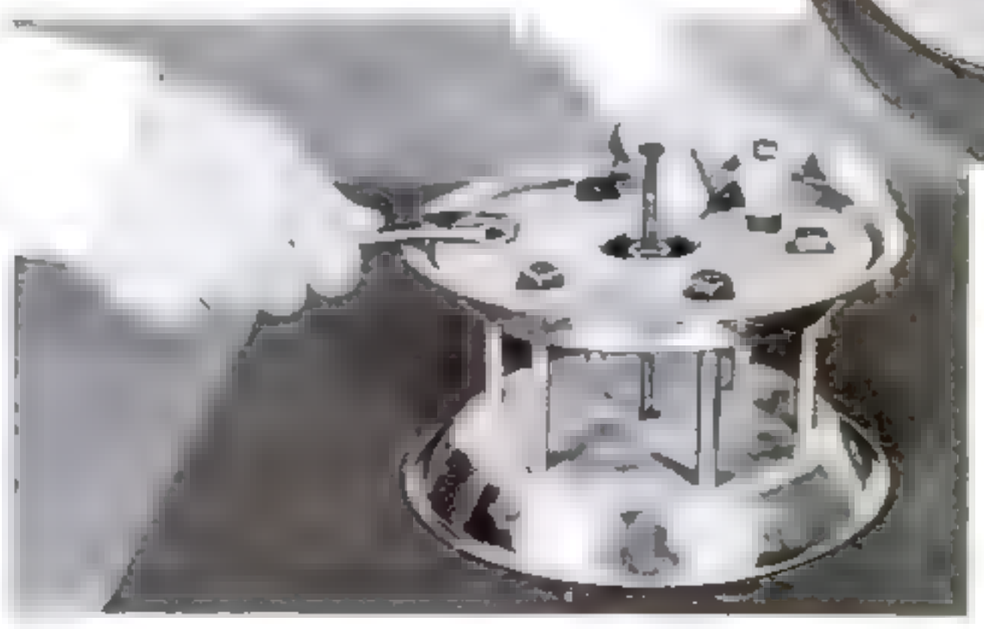


How the trolling bracket or other support is fastened to the reel. The wooden disk between the two pie plates is also clearly visible. At the left is shown the drilling of holes to secure the wheel

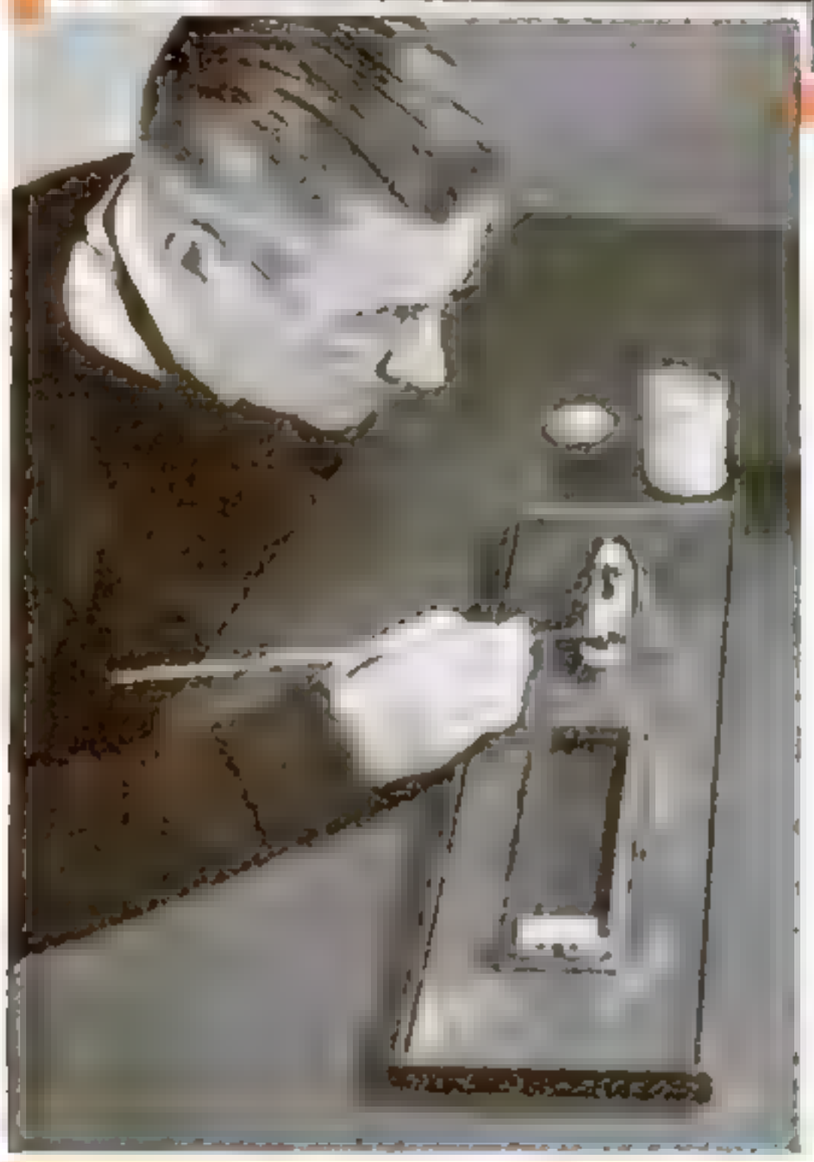
To assemble the smaller reel, the center bolt is removed, a longer one is slipped in, and the skate wheel is placed over it. Then ⅛-in. holes are drilled through the wheel and plates to take the bearing bolts. Do the same for both bearings. This method will make the reel run true. The reel is now taken apart, the center holes enlarged to ½ in., and recesses cut in the disk for the bearing bolts. A 5/16-in. hole is drilled for the handle pivot bolt, which is locked in place with a nut on either side of the reel. The handle is turned on a lathe and bushed with a piece of 5/16-in. inside diameter brass tubing, forced in by hand.

In the larger reel, the center bolt is removed, and the center holes in the wood disks are bored out with an expansion bit to take the skate wheels in a light tap fit. The center holes in the plates are drilled out to ½ in. The hole for the handle is drilled, and the reel is assembled with 5/16-in. inside diameter brass tubing slipped over the bolts as spacers.

A bracket for trolling also is shown. This is shaped from ¼-in. strap iron, and is slipped over the seat of the boat. For kite reels, a similar bracket can be made and strapped to the operator's body.



If a reel of still larger capacity is required, it is assembled as shown at the left. The plates are held apart with brass tubing slipped over the bolts. In this case the skate wheels are tapped into large holes bored in the wooden side-pieces, as illustrated above



Miniature models of harbor tugboat and tow in a scenic setting, and a top view of the same models mounted on a 6 by 18-in. baseboard, grooved at the edges for a glass case

• *Something New for Model Makers* •

TUGBOAT *towing a* BARGE

TUGBOATS are the picturesque busybodies of the harbor. You'll see a score of them for every large, deep-sea vessel. Some guide liners to their berths, fetch their water-born cargoes, and tow disabled ships from the sea; others tow barges with railroad cars and all sorts of bulk goods. It is one of the latter for which we give plans this month—a typical harbor tug with a typical lighter.

This tug is the *Maren Lee* of New York, one of the great fleet operated by the lighterage firm of Lee and Simmons. There is such an immense variety of tugboats of this general type that you are at liberty to alter any details and the colors or funnel badges to suit your fancy. By the way, it is correct to refer to a tugboat as a steam tug or a towboat and to her tow as a lighter or a barge.

The dimensions of the *Maren Lee* are: Length (between perpendiculars), 83 ft.; beam, 24 ft.; depth, 10 ft. 8 in.; 140 gross tons. It is our purpose to tell in detail how to make a miniature water-line model of her on a scale of about 1/16 in. equals 1 ft., and also to give suggestions for building a barge on the same scale, so that a scenic arrangement may be made similar to that illustrated in the accompanying photographs.

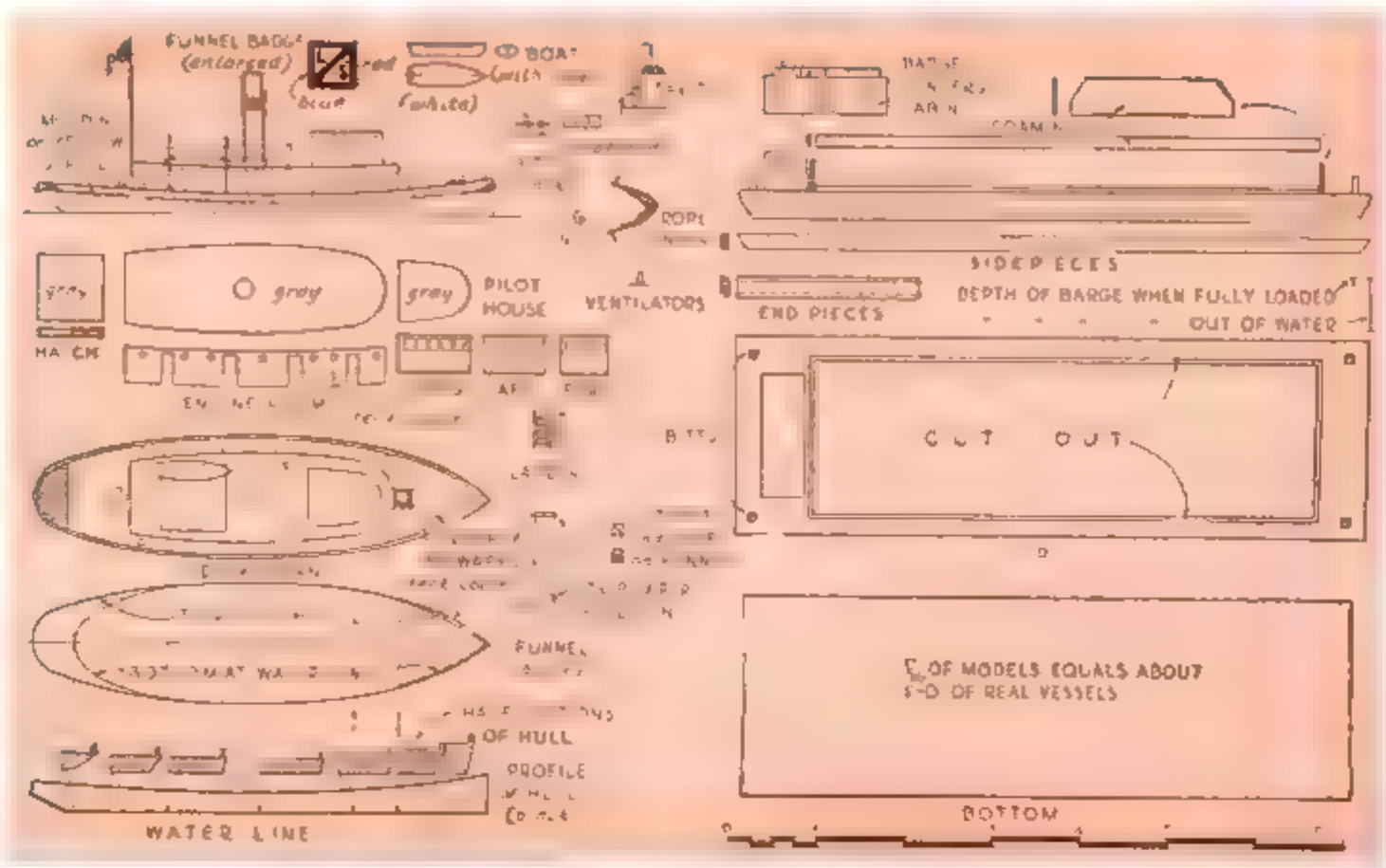
In addition, for the benefit of those readers who wish to make a larger and more elaborate model, we are giving on the opposite page drawings of the actual tugboat with a scale in feet. The complete hull is shown so that an accurate model may be made, either by the bread-and-butter or the frame-and-plank method. If you wish to construct a larger model, a convenient scale to adopt is ⅛ in. equals 1 ft. At the end of the article a list of materials is given for making a scale model of the tugboat alone to this scale.

In making the miniature water-line model of the tugboat and barge, the simplest method of construction is as follows:

Hull. Cut a 7/16-in. thick piece of soft wood to the shape of the top of the hull. Sandpaper it a bit at the bow and round it underneath the stern until the bottom conforms with the bottom line of the hull. Mark the inside lines of the bulwark and shave down, inside these lines, to the deck level, except at the stern platform, which is only half the depth. Mark the deck level on the outside, and along the line glue a thin piece of cord to form a molding. If you dip the right finger and thumb in glue and draw the cord between them to glue it, then hold the end at the stem and press it along the mark with a wet left thumb, it goes on quite easily.

Paint the molding yellow and the rest of the hull black. The deck is natural wood (varnished, if you wish); inside the bulwarks, teak color (red-brown). The platform for the hawsers to lie on is dark with white stripes, representing battens.

Engine Room. Cut a piece of 7/16-in. wood to the shape shown. Give it a little



Complete drawings for the two miniature models. Dimensions may be found by referring to the scale

Designed especially for the
POPULAR SCIENCE
MODEL-OF-THE-MONTH CLUB
By
Capt. E. Armitage McCann

The tugboat model itself is 5 3/16 in. long. Although it is easy to make, the effect is realistic

sheer (curve) to match the hull sheer. Paint the sides teak color and the top gray. Paint the round portholes pale blue. With pen, brush, or black pencil, mark the doors. Glue this part in position.

Pilot House. Cut this from another piece of the same thickness. Paint a pale blue stripe all around, except part of the after side; divide this with bars of teak color, and color the rest of the house the same. Mark in the door. Paint the top gray. Glue in place.

Hatch. Cut this from 3/32-in. thick wood and paint windows around the edges. Teak trim and gray top.

Funnel. This is a ¼-in. round stick. If you want to put the rim on top and the hood below, cut strips of paper, 1/16 in. or less wide; glue them and wrap around until you have sufficient thickness; and when dry, round the top band and bevel the lower one with a sharp knife or file. The badges, or company marks, are painted on thick paper and glued on. The rest of the funnel is black. Bore a hole in the engine room roof at a slight rake aft to set it in, or just glue it on.

The exhaust steam pipe, abaft, and the whistle are No. 20 wire painted black. (If brass wire is used, leave the tips bright.) Instead of a whistle, a siren can be indicated by bending over the end of the forward rod.

Ventilators. Whittle these from a piece of ⅛-in. square stick. They are white with red mouths.

Boat. This is whittled out of a scrap of wood as shown. It has the cover on, so is level on top along the center and cut down to the gunwales at the sides. It is glued on the hatch on the port side. The davits are pieces of No. 20 wire (tapered to the top if you wish), set into the main deck close up to the engine room.

Bitts. The forward pair of towing bitts are set fore-and-aft, and another pair aft are set athwartship—1/16-in. round sticks driven into the deck, with oblong slips of cardboard drilled to fit over the posts to represent the crosspieces. There are also four single posts where indicated and one short one in the bow. All are black.

Ladder. This may be indicated with white and black paint on a slip of wood, or have dug-out or built-up steps.

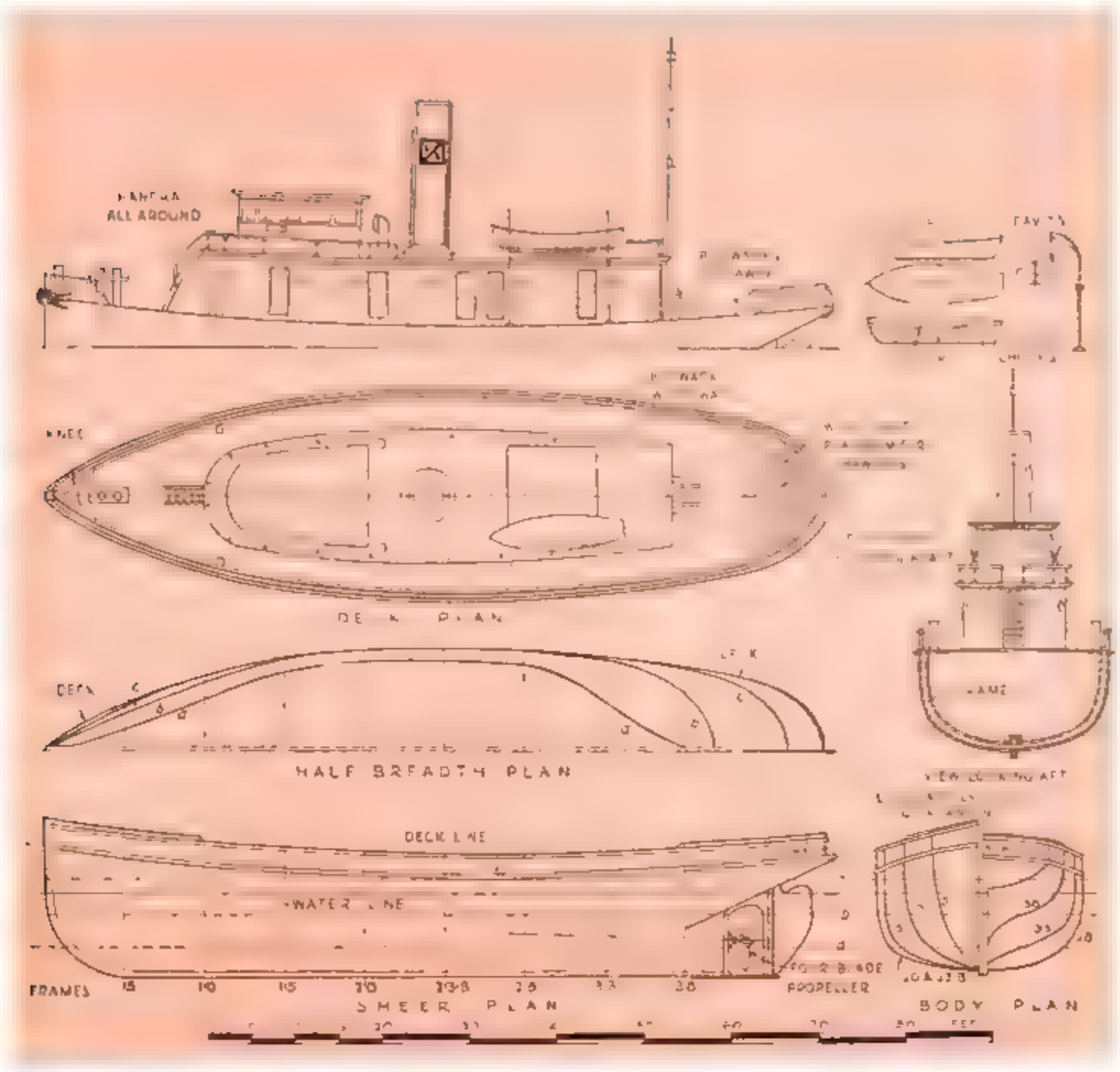
Mast. A piece of 1/16-in. round wood, tapered to the top. It is white nearly as high as the funnel, and black above. Glue on an ensign if you like. It should really carry one lantern to shine forward and three shining aft, but the model is rather small for this refinement.

Fender. I made this of darning cotton with a crochet needle, thick in the middle and tapering to the ends, which are fastened by driving them into holes in the hull with pegs. It should be brown to look like rope.

Tugs that handle ships or tow alongside have side fenders, such as 6-in. diameter logs, hung from the rail, but when towing ahead these are not needed.

You may put the name and port of registry in white letters on the stern.

Painting and Finishing. The more carefully you smooth all parts, the easier the painting will be. If you shellac and lightly sandpaper the parts, then one coat of paint should be sufficient. The teak color on the real tugs *(Continued on page 102)*



These are the plans of the actual tugboat with a scale in feet so a model of any size may be made

Pin Stripes

GIVE YOUR MODEL A MUSEUM FINISH

By T. R. Phillips, Jr.

A flexible guide for ruling stripes may be made from wire solder, or rubber tubing slightly flattened by grinding. A drafting pen, modified as shown below, is used for striping

HAVE you ever critically examined the beautiful models in museums and at exhibitions? How the paint finish glistens, and how fine and delicate the pin stripes are! You naturally thought that painting those stripes must have been a tedious job, yet you can duplicate them very easily; and having once learned the tricks, you will find numerous opportunities to use the technique. For instance, you may want to pin stripe your car, or decorate some instrument you have made.

Then, too, you can use the same method when making fine dividing lines where the colors change at the water line on your boat models. Ordinarily this is done by pasting a paper mask on the hull, painting up to its edge, and removing the mask after the paint dries. That's where trouble sometimes develops; when the paper mask is removed, the dividing line becomes ragged. The method to be described will enable you to make those fine dividing lines almost razor edged. Furthermore, stripes or dividing lines may be run around all kinds of odd corners and over irregular surfaces with ease.

The actual striping is done with a drafting pen, which must be especially prepared for the work. It is necessary to provide more surface within the pen for the paint to cling to than when using the same pen with water-compounded inks. If this is not done, paint flows from the pen too freely. A simple little metal tongue will do the trick. Made of thin sheet metal as shown, it is inserted in the pen between the blades and is held in place by means of the regular adjustment screw. Notice that the tongue is wavy. This shape provides many small wedge-shaped crevices.

Now we come to the paint itself. Ordinary pigmented varnishes and enamels creep badly and will destroy the fineness of hair lines. It is much better to make your own paints, testing them each time before using them to make sure that they will not spread after being applied to a model. For this purpose a few tubes of ground-in-oil pigments of the desired colors should be purchased. The actual mixing is best done on a glass plate with a broad metal spatula. Squeeze out a small amount of the pigment onto the plate, add a few drops of clear varnish, and smear the mixture around with the flat of the spatula until it is well mixed. Scrape it into a heap and see if it is barely fluid enough to run from the spatula in an unbroken stream. When it does, add just enough pigment to stop the running.

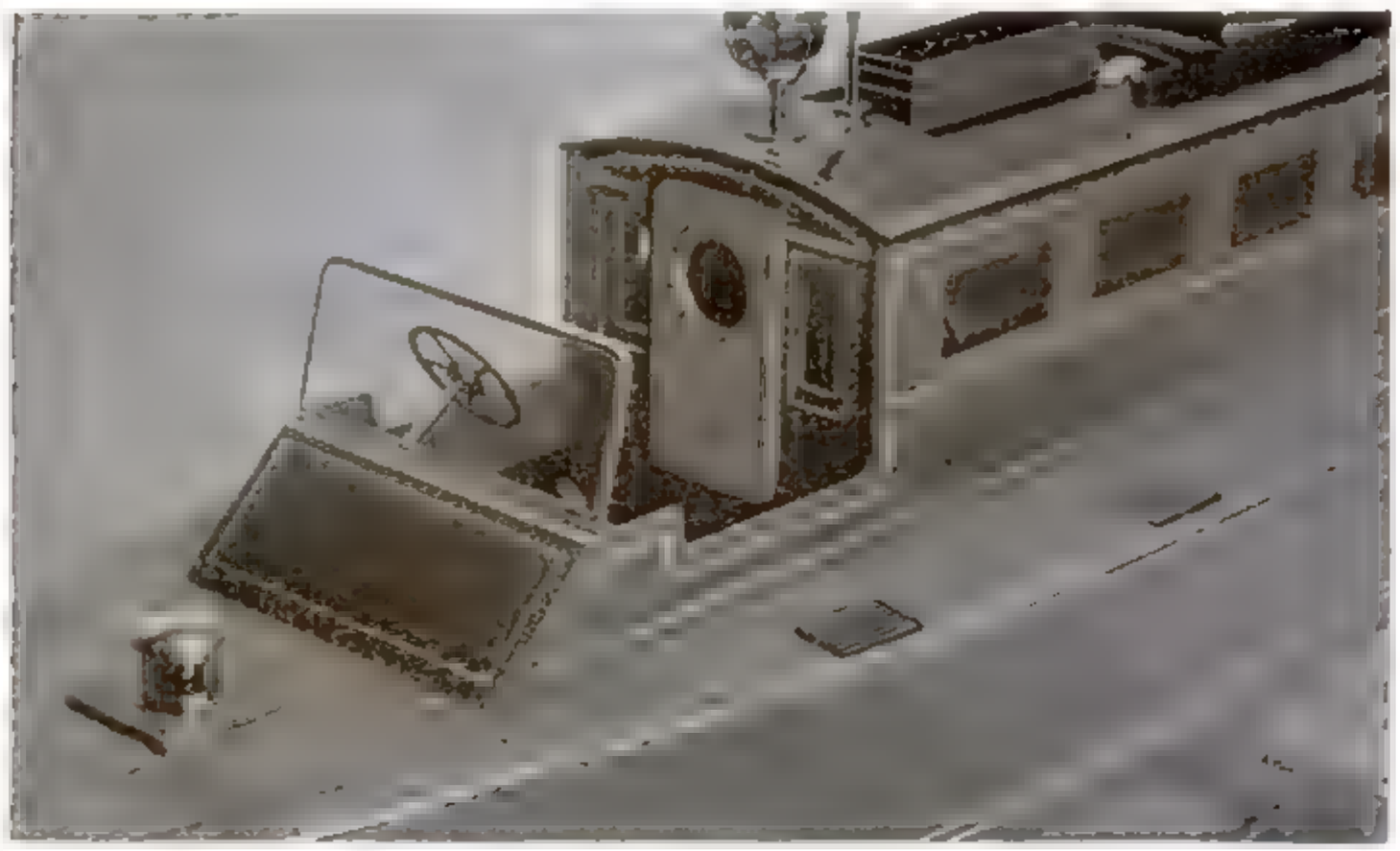
When loading the pen, be careful to see that the outsides of the blades are clean. Any paint here may lead the paint from inside the pen around the blades and onto the work. It is best to screw the blades together when loading the pen, and clean the outside with a small piece of linen before use.

The preparation of the surface is also important. Pumice and oil are used to rub down the surface where the pin stripes are to be made. Generally the final paint coat is rubbed down prior to finishing with varnish, and it is best to do the pin striping at this time so that the finishing varnish will protect them. If the stripes are to be put on over a high-gloss enamel, then a narrow strip where the stripes are to go should be dulled slightly with the pumice-in-oil mixture. A small piece of linen tied over a lead pencil eraser forms a handy rubbing pad. Just before striping operations begin, the surface should be rubbed with the palm of the hand to remove all dust particles.

The neatest stripes are always made continuously from beginning to end. On flat surfaces, templates of heavy cardboard or celluloid may be used, but where the surface is irregular or corners are to be turned, a special form of guide will be needed.

A ruler of extreme flexibility is easy to make from a piece of ⅛-in. rubber tubing. The tubing should be ground flat on one side along its entire length. This may be done by running it between a grinding wheel and the tool guide or rest, after properly adjusting the clearance between guide and wheel. Before the ruler is to be used, this flat surface is coated with rubber cement, which is allowed to dry. When dry, the cement will still be sufficiently tacky to enable the tubing to be attached to irregular surfaces simply by pressing it into place. It may be removed from the painted surface without the slightest injury to the paint.

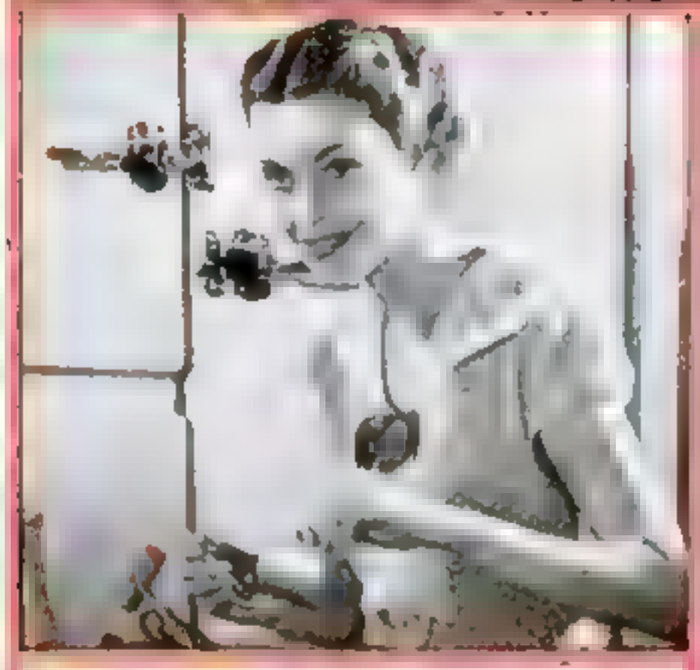
Quite often ordinary wire solder may be used to form a ruler for the pen. The wire should be straightened perfectly before it is bent to the special shape required. This may be done by stretching it slightly with pliers and a vise. Then place it carefully on a flat board until needed.



The addition of neat pin striping always gives a model a more professional look. These stripes were applied with a draftsman's pen, which was guided by templates and rulers as described

FOR DIGESTION'S SAKE—SMOKE CAMELS

A RARE PLEASURE. At the left—leisurely diners enjoying the continental *cuisine* at Jacques French Restaurant, a nationally famous *café* in Chicago. Here it is that soft lights and impeccable service give the perfect setting for such dishes as Baked Oysters *à la Jacques* and other specialties of the house. And Camels add the final touch to dining. "Camels are most popular here," Jacques himself (*above*) observes. "They are the favorite with those who know fine living."



MRS. HAL LEE, pictured here in the kitchen, says, "When telephone, doorbell, housework, and planning stretch my nerves taut—it's hard on digestion. I smoke Camels to help keep my digestion in healthful working order."

Smoking Camels a Pleasant Way to Ward Off Effects of Worry and Strain on Digestion. Camels Set You Right!

Modern days are tense and trying. Nerves get "wound up." Hurry, worry, and strain tend to interfere with normal processes of digestion.

Smoking Camels helps to restore and increase the flow of fluids so necessary to good digestion. You sense a comforting "lift" and feeling of well-being as you enjoy the delicate fragrance of your Camel.

You can smoke Camels steadily. The matchless blend of Camel's costlier tobaccos never gets on your nerves or tires your taste.

THE FLARE of the welding arc climbs to 8700° F.! Dan Rafferty, master welder, says: "Smoking Camels during and after meals helps my digestion."

THE WINNER! Kelly Petillo *(left)* takes the 500-mile Indianapolis classic. Petillo says: "Smoking Camels goes a long way in helping my digestion."

COSTLIER TOBACCOS

● **Camels are made from finer, MORE EXPENSIVE TOBACCOS...Turkish and Domestic...than any other popular brand.**

Variable Transformer

Gives Perfect Control of PHOTOFLOOD LAMPS

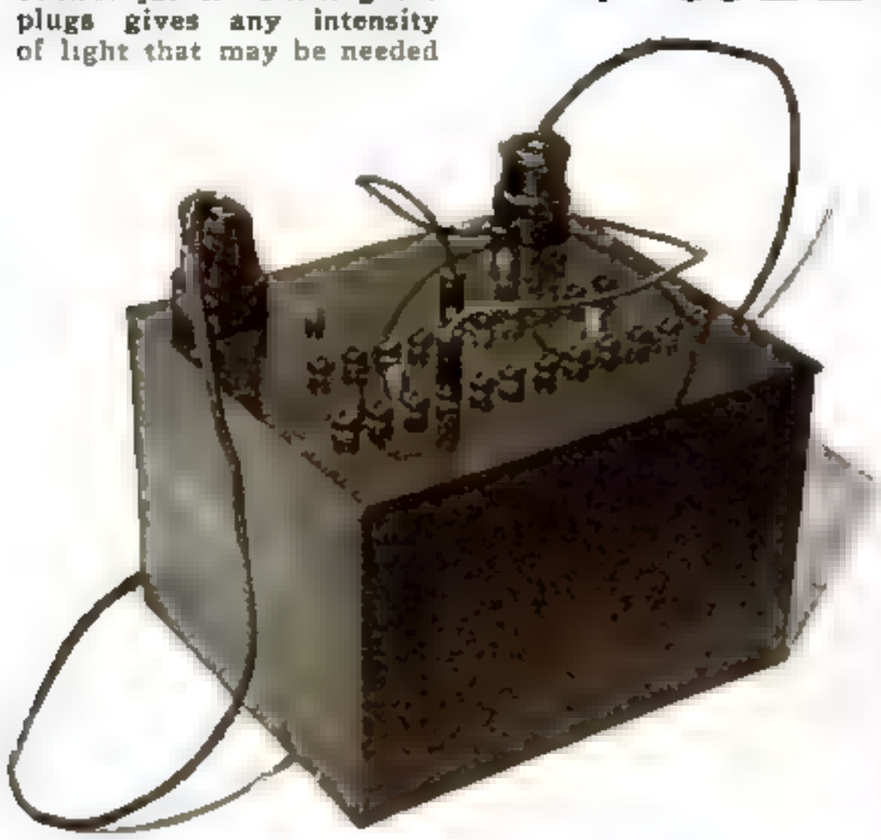


Fig. 1. The transformer is mounted under the panel, which carries the voltage-control jacks. Shifting the plugs gives any intensity of light that may be needed

Easily Made Device Is Aid in Lighting and Enlarging—Quickly Saves Its Cost by Lengthening Life of Bulbs—Has Range of from 0 to 140 Volts by 1-Volt Intervals

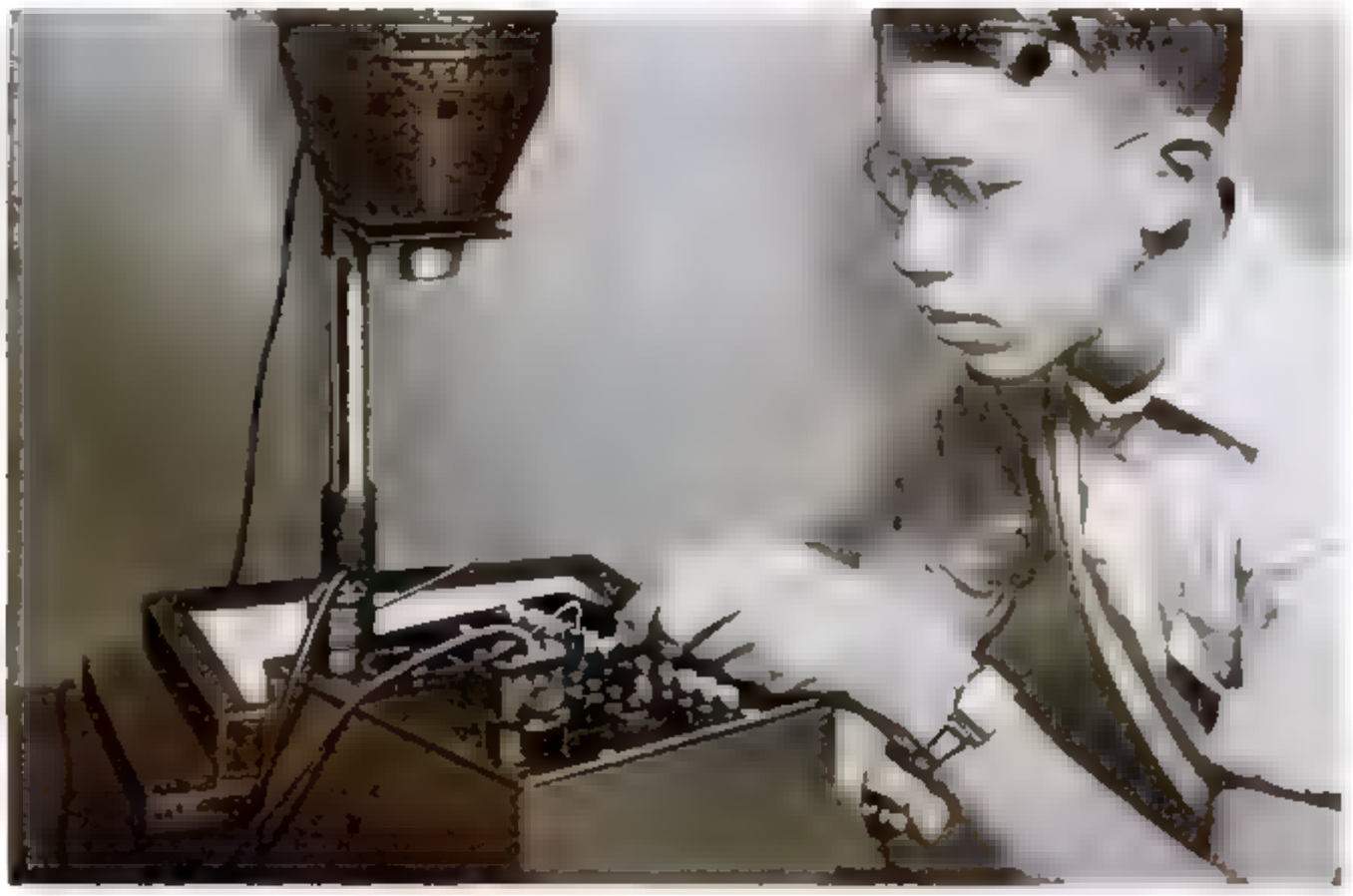


Fig. 2. Besides providing economical control of illumination in taking photographs, the device is valuable for regulating the voltage of a photoflood lamp used in an enlarger

By H. P. WESTERVELT

ALTHOUGH the photoflood lamp is one of the best light sources for the amateur photographer, it has one disadvantage in that its life is comparatively short when operated at its rated line voltage. If a method of controlling the voltage is applied to these lamps, their life can be increased several hundred percent and their usefulness, both for subject lighting and projection printing, greatly increased.

The voltage control to be described has been in use in the writer's laboratory for many months and has paid for itself many times over. It enables four No. 1 photofloods to be used at once and provides a variation of voltage from 0 to 140 volts in 1-volt steps from any 115-volt, 60-cycle lighting circuit.

The device consists of an autotransformer with a number of taps on the winding for obtaining the desired voltage. The materials for building it may be found in almost any radio service shop, and the form may be varied to suit the builder's desires and the parts obtainable.

The portion that must conform to set specifications is the iron core and its associated winding. The core consists of a pile of iron strips, which may be taken from an old radio transformer. The bare core will look something like the drawing marked Fig. 5, and a transformer should be selected in which the core area, dimension *A*, multiplied by dimension *B*, is equal to at least 2 sq. in. This is important, because if the area is less the transformer will not carry the load without heating.

When a suitable radio transformer has been obtained, strip the old winding from the core, but be sure to save the insulating tube that will be found between the core and the inner layer of wire. This tube will be used for the same purpose in the new transformer.

The new winding will require approximately 2½ lb. of No. 18 B. & S. gauge, cotton-enamel magnet wire. A winding form should be made up from a wooden plug of a size to fit the insulating tube taken from the old transformer and two plywood ends to hold the winding in place until it is mounted. The winding form used by the writer is shown in Fig. 6. Cut two end pieces from cardboard to fit snugly over the insulating tube and inside the winding space on the core. These are to prevent the wire from coming in contact with the core iron when reassembling the transformer.

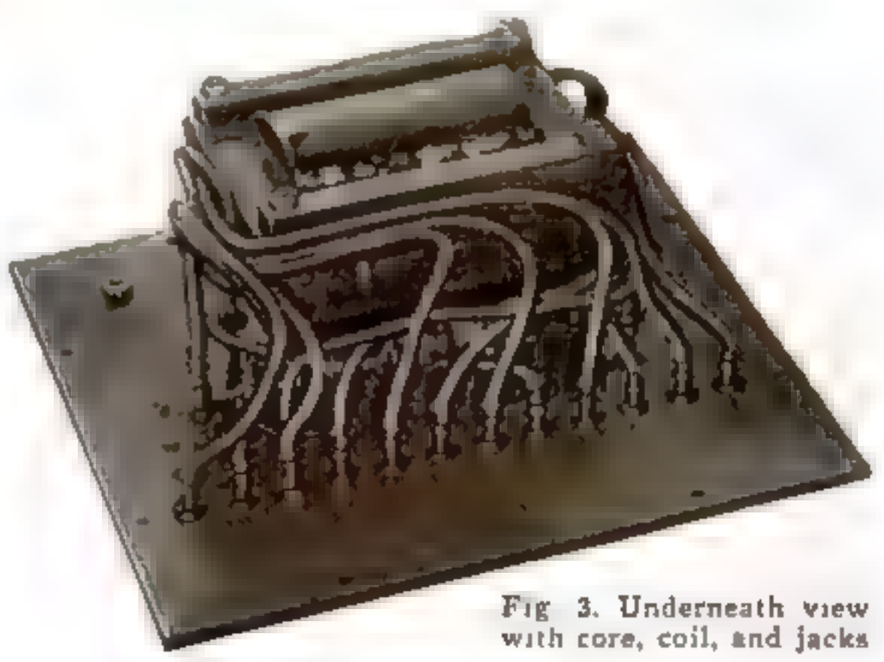


Fig. 3. Underneath view with core, coil, and jacks

The winding form, insulating tube, and end pieces are now assembled and bolted together, and saw slots are cut in the end pieces through which the wire may be run for the taps. Be sure that these slots are cut so that the taps will be taken out from the portion of the winding which is outside of the core, otherwise there will not be room and the core cannot be assembled. The assembled winding form is now mounted in a bracket, also shown in Fig. 6, and fitted with a crank for turning. The mounting should be about 1 in. wider than the length of the winding form, as the wire from the tap *(Continued on page 92)*

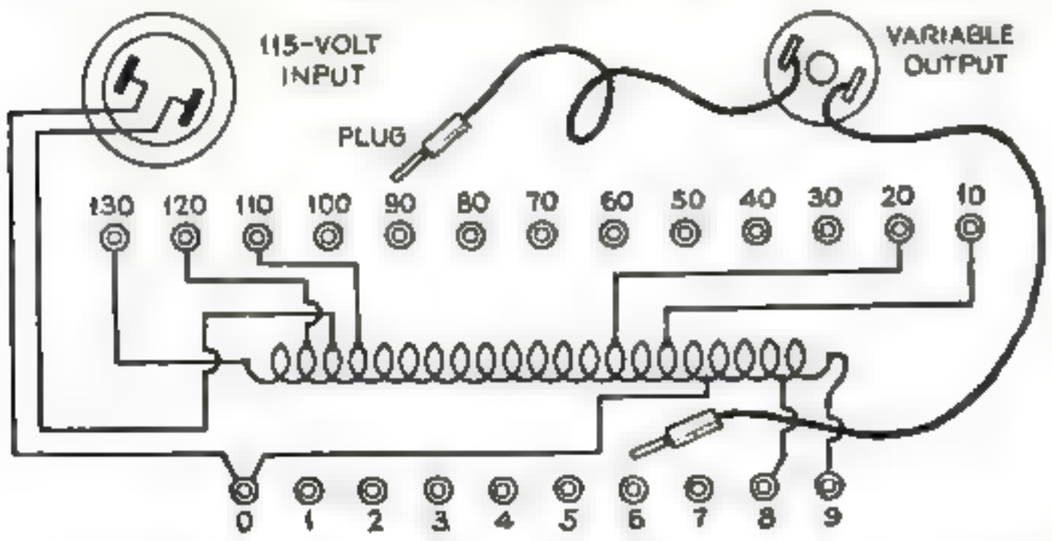


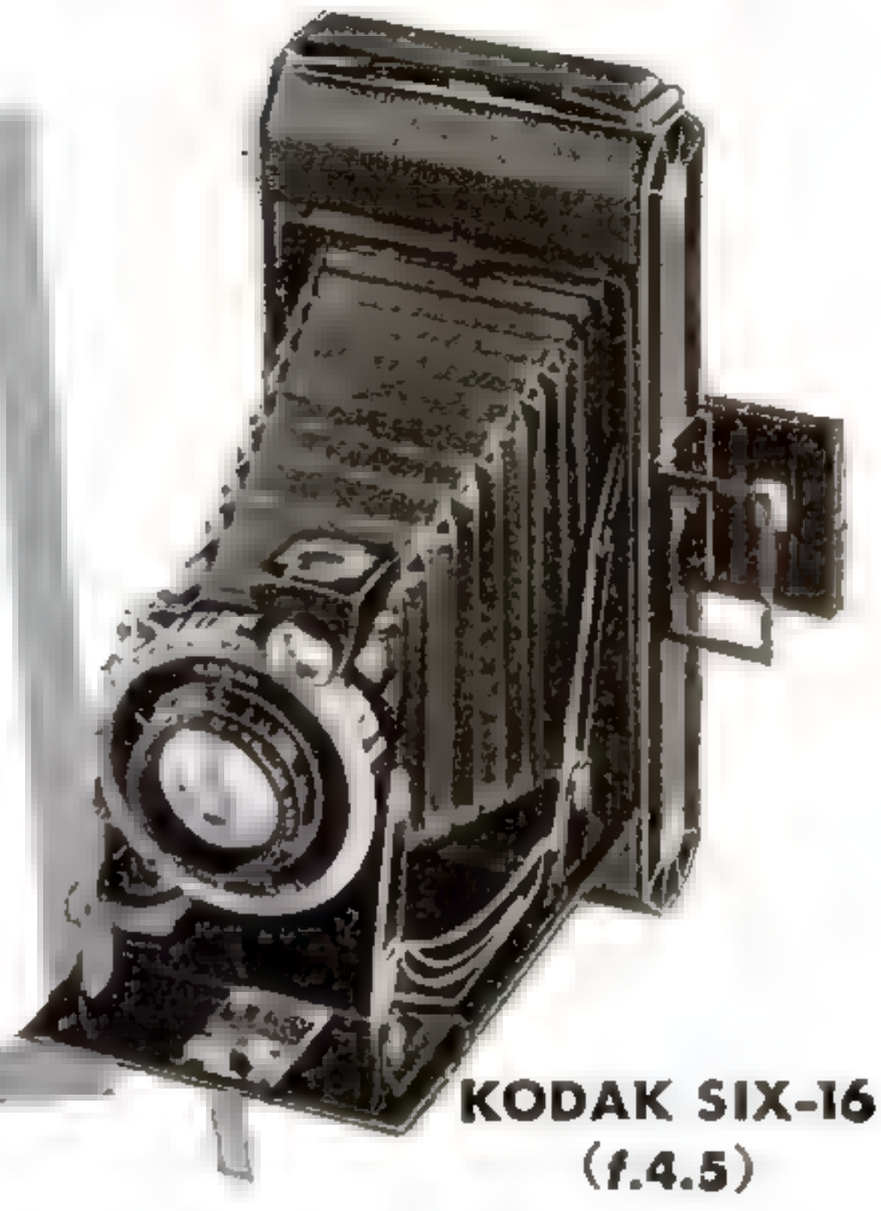
Fig. 4. The wiring diagram. To avoid a multiplicity of confusing lines, only a few of the connections to the jacks are shown

No wonder it's

America's favorite fine camera—

It has all these features

fast *f*.4.5 lens . . . 8-speed Compur shutter up to 1/250 second . . . delayed-action timer . . . close-up focusing . . . eye-level finder . . . action front . . . roll-film convenience . . . large picture size.



KODAK SIX-16
(*f*.4.5)

KODAK SIX-16 with the fast *f*.4.5 Kodak Anastigmat lens is America's most popular fine camera, by a wide margin. And a glance at its many features shows why it's a natural "first choice."

This up-to-date Kodak springs into action at the touch of a button . . . has both eye-level and waist-level finders. The *f*.4.5 lens makes bright snapshots even in difficult light . . . indoors at night with Photofloods . . . in the rain . . . on cloudy days; and the high-speed shutter "stops" action. It's a real all-arounder for one-camera fans. Makes 2½ x 4¼-inch pictures. Costs but $40. See it at your Kodak dealer's.

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For enlarging—Kodak Panatomic, the film with the microscopic grain. Leads to enlargements of contact-print quality. Fully panchromatic, too, and amply fast for all average pictures.

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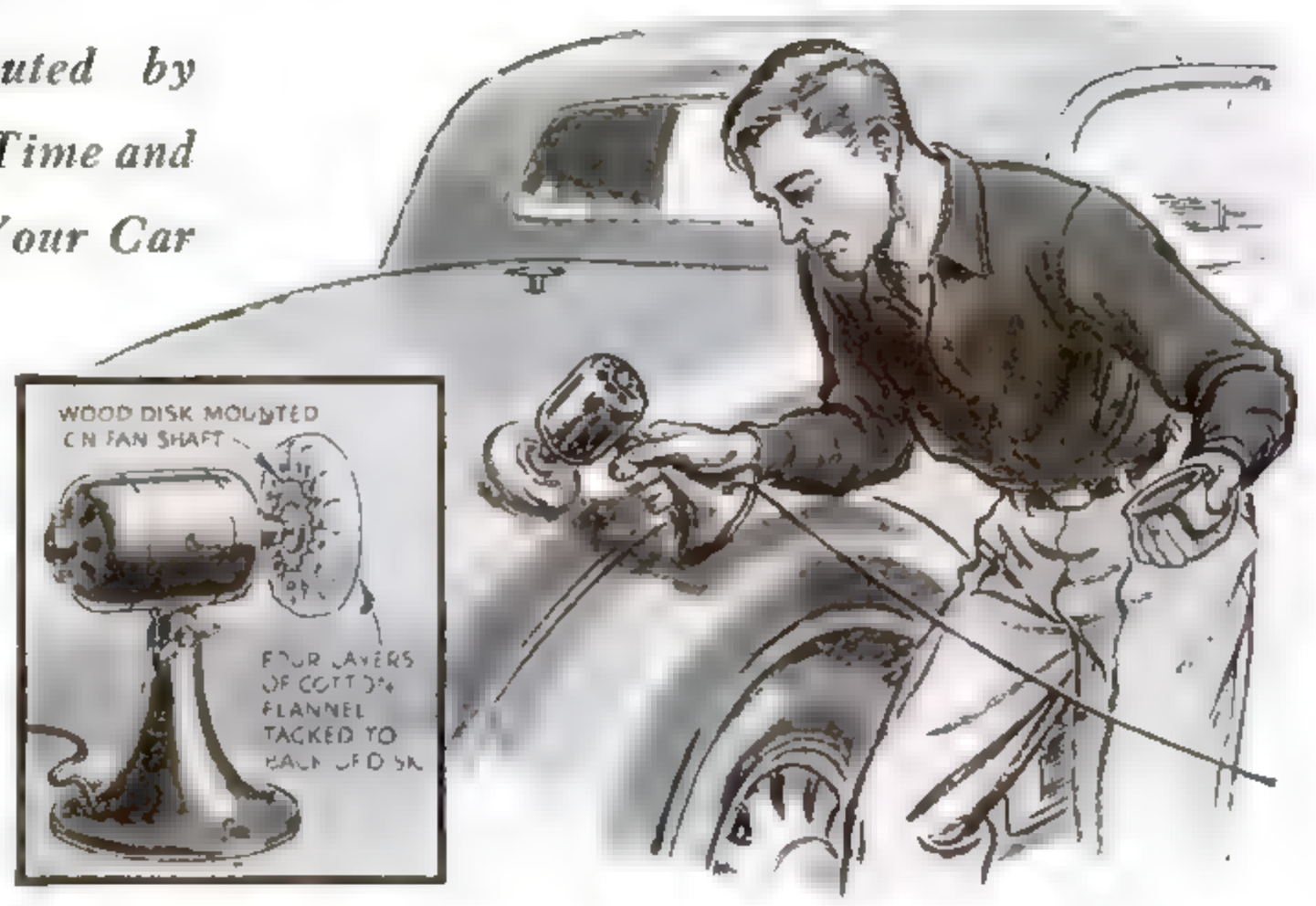
P. S. 6-36

Useful Kinks *for* Motorists

These Suggestions, Contributed by Our Readers, May Save You Time and Money in the Operation of Your Car



A padded disk, fitted to the shaft of an electric-fan motor, makes car polishing easy

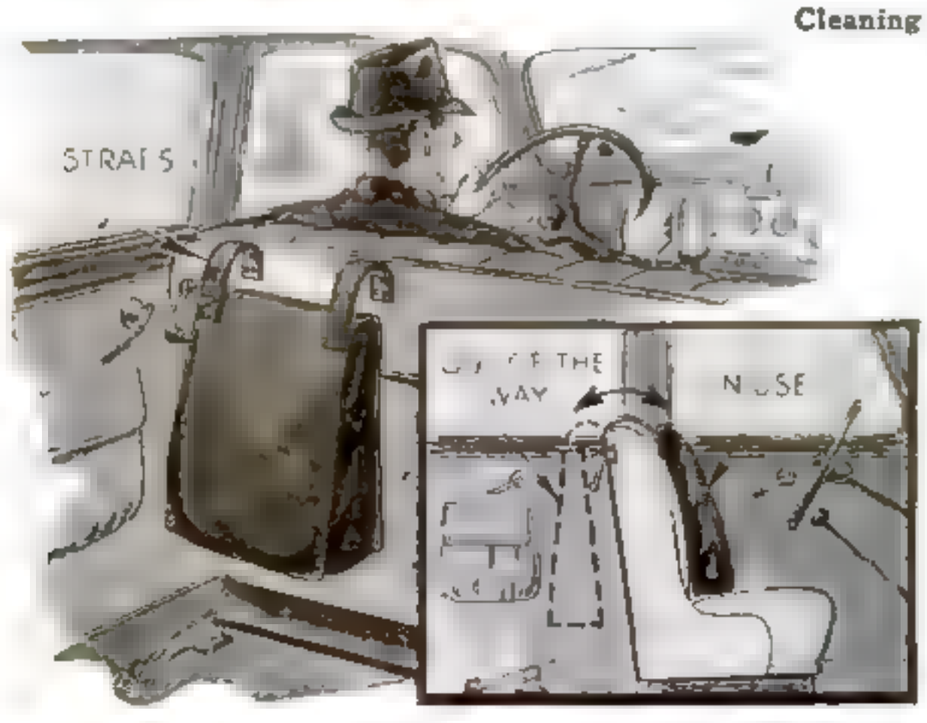
CAR waxing can be made much less of a job by making use of your household electric fan. The wire guard and fan blade can be removed easily. All that is necessary then is to mount a soft-wood disk on the shaft and pad it with flannel. Since little pressure is needed for polishing it will not harm the motor and the fan can be restored to its original use in a very few minutes when the job is completed.—A. H. W.

"Canned Heat" Keeps Windshield Clear

SOLIDIFIED alcohol, sold as canned heat, rubbed on your windshield will prevent rain from sticking in droplets and obscuring your vision. The material contains a waxy oil that sheds the water as effectively as the more expensive alcohol-glycerine preparations.—E. N.

Driver's Extra Cushion Hung From Top of Seat

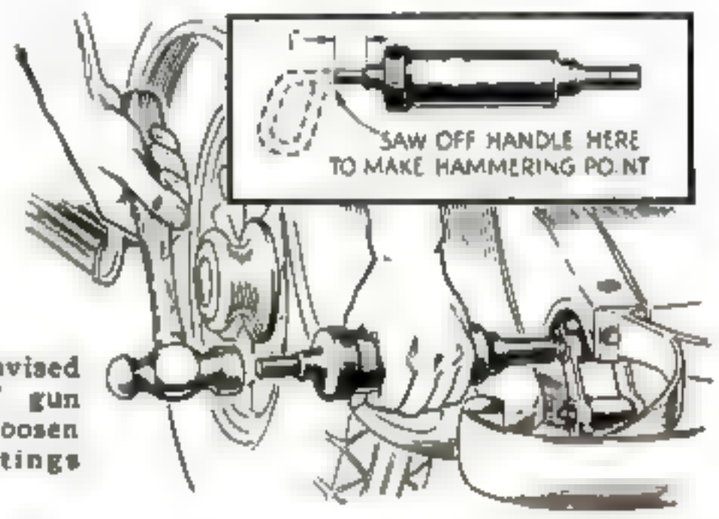
THE problem of storing a driver's back-rest cushion when it is not in use can be solved by sewing two straps to the upper end of the cushion and fastening them to the seat as shown. When not in use, the cushion is allowed to hang back over the rear of the driver's seat.—N. E.



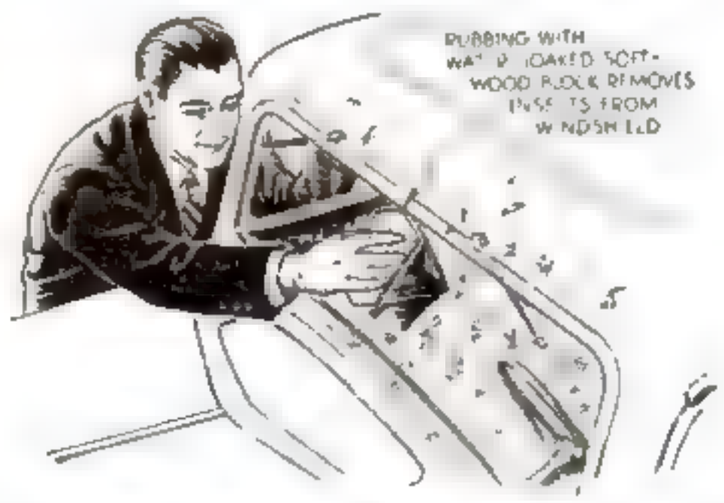
Held by two straps, driver's back rest can be swung out of way

Impact Grease Gun Opens Clogged Fittings

To OPEN clogged grease fittings, a "shock-type" grease gun often is the only tool that will do the trick. An ordinary grease gun can be altered to serve the purpose simply by sawing off the handle to leave about one inch of stem. In use, the gun is placed on the fitting and the short stem struck with a hammer. The impact of the hammer blow will force the grease through most clogged fittings.—E. T. G., Jr.



How an improvised "shock-type" gun is used to loosen clogged fittings



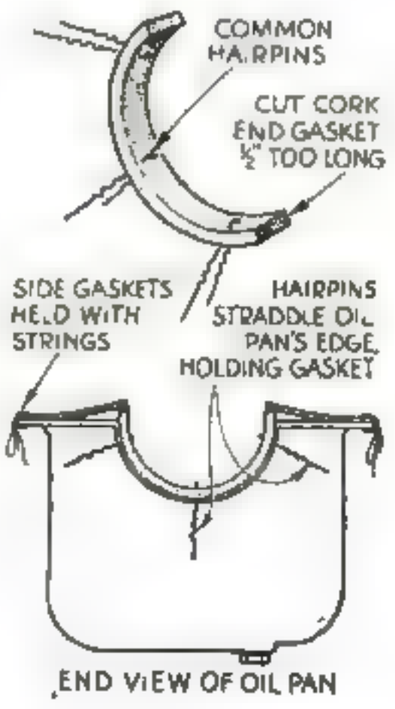
Cleaning windshield with water-soaked block

Removes Bugs From Glass With Wet Wood Squeegee

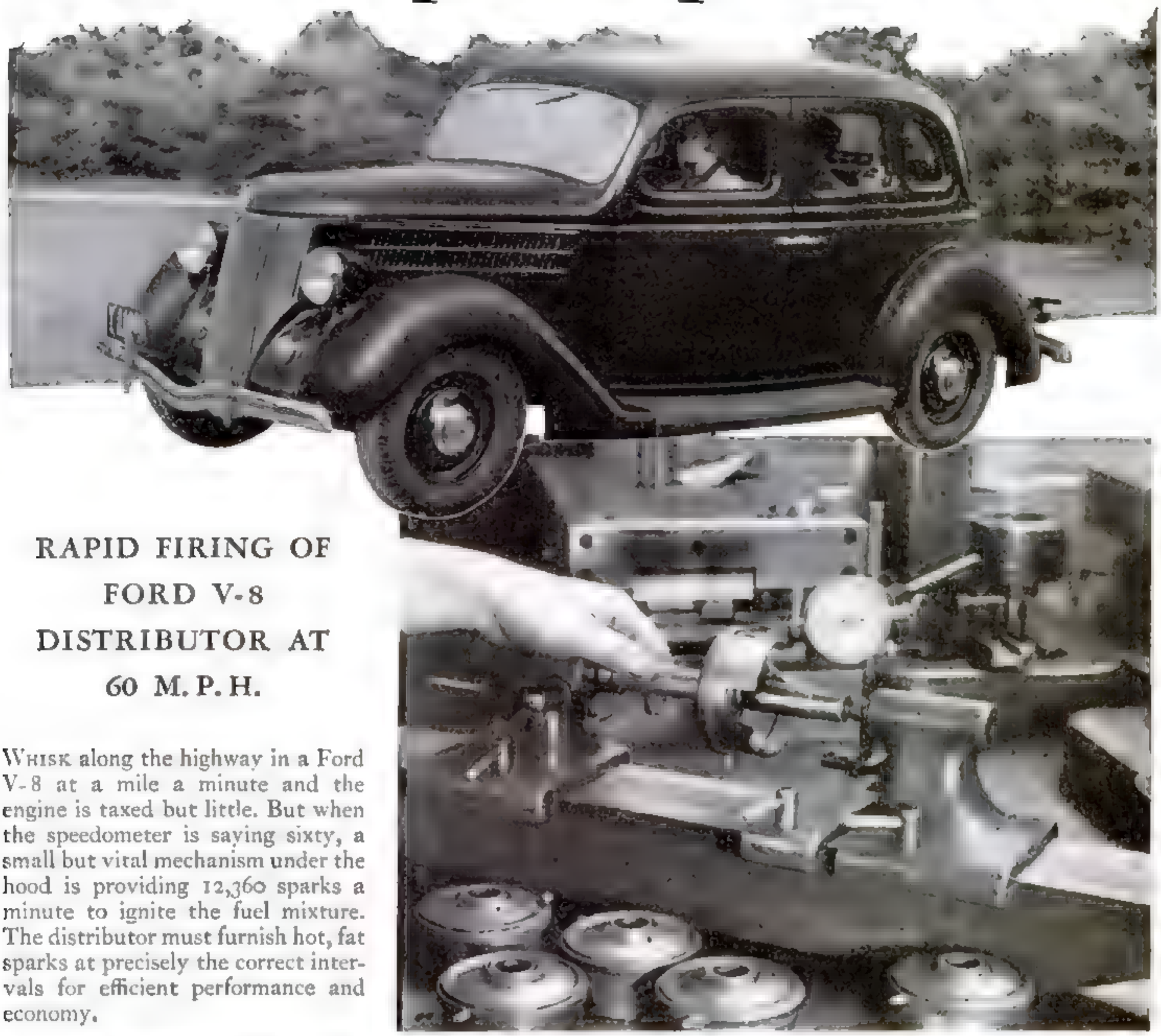
HERE is how one car owner solved the "buggy" windshield problem: In one of the door pockets of his car he keeps a small block of soft wood provided with shallow, parallel saw cuts on one of its flat surfaces. To remove the accumulation of squashed bugs after a day's trip, he simply soaks the block in water until it is well saturated and then rubs it as he would a squeegee over the insect-incrusted surface of the windshield.—J. P.

Hairpins Anchor Gaskets

WHEN placing oil-pan gaskets on cars that use flat cork strips, the amateur mechanic can save time and prevent leaks by following the kink illustrated. First the end cork should be about one half inch too long so that it will squeeze into place and prevent gaps. Next three hairpins should be pushed through each curved cord strip so that they straddle the edge of the pan. They can be locked in place by pinching the ends together. The flat pan gaskets, placed so their ends overlap the end gaskets, can be tied with strings through the bolt holes. It is not necessary to remove the strings and hairpins when the mounting bolts are tightened. They will squeeze into the gaskets.—T. W. B.



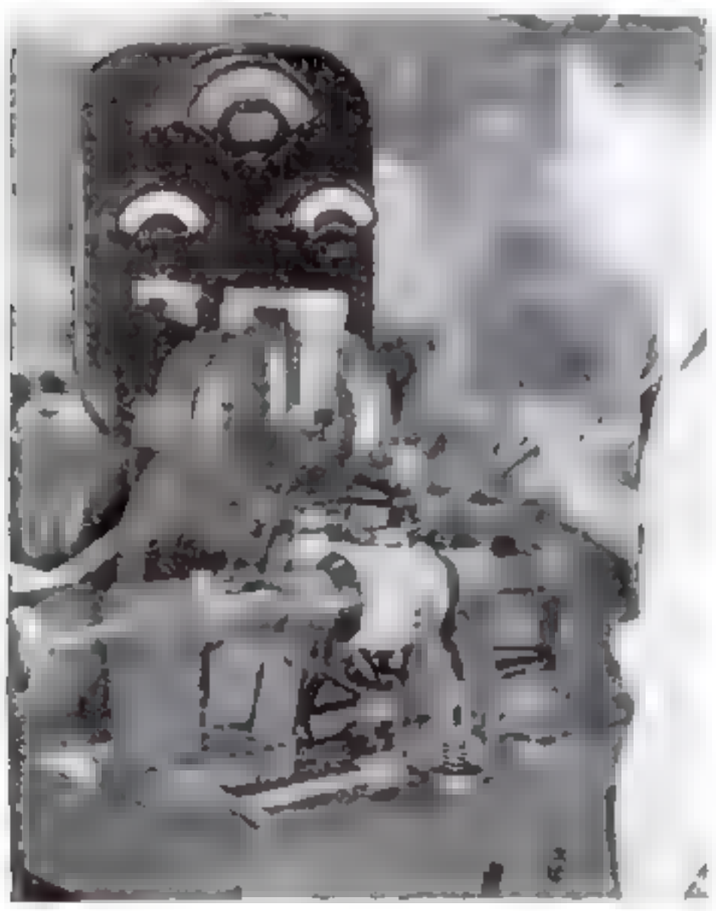
12,360 *Sparks per* Minute



RAPID FIRING OF FORD V-8 DISTRIBUTOR AT 60 M. P. H.

WHISK along the highway in a Ford V-8 at a mile a minute and the engine is taxed but little. But when the speedometer is saying sixty, a small but vital mechanism under the hood is providing 12,360 sparks a minute to ignite the fuel mixture. The distributor must furnish hot, fat sparks at precisely the correct intervals for efficient performance and economy.

This gage makes sure that the distributor bearing is at right angles with the face of the advance housing flange.



This special testing machine checks the distributor for timing, automatic advance, and vacuum brake setting.

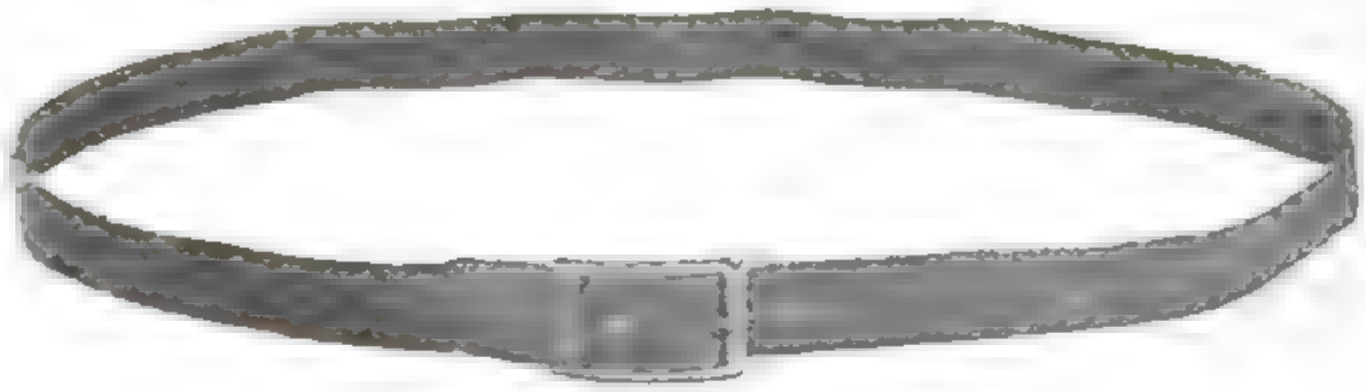
Compare these 12,360 sparks to the 1440 photographs which pass through a modern motion-picture projector in the same time—or to the 3600 ticks of the second hand on your watch. Then you will have an idea of the important job done by the distributor on a Ford V-8.

Yet a Ford distributor seldom needs attention. After thousands of miles of use, if it should require repair, your Ford dealer will exchange it for a distributor that has been rebuilt completely at the Ford factory. Then you get the benefit of factory inspection and reconditioning, instead of local repairs—workmanship by men who have every needed tool or machine at hand. Parts which do not pass their minute inspection in every respect are rejected, and replaced with new parts. The exchange distributor costs little more than the conventional operation of changing points.

Every reconditioned Ford distributor must meet the performance standards of brand-new distributors. That's one of the reasons why the Ford Service Exchange Plan, which also includes many other important assemblies, is so popular with Ford owners. It saves them time—it saves them money.

GENUINE Ford PARTS

FORD MOTOR COMPANY



Novel SPORT BELTS

Woven from Wrapping Paper

By KENNETH MURRAY

ATTRACTIVE and surprisingly durable sport belts may be made from wrapping paper at a cost of only five or ten cents each. They have a general resemblance to expensive hand-woven leather belts and, in addition, can be made in special weaves and color combinations to suit the wearer's tastes and match his clothing.

Get a piece of heavy, tough wrapping paper about 60 in. long and cut it into strips about ½ in. wide. Each strip should then be given a thin coat of either library paste or waterproof casein glue, the latter being preferable because it adds to the strength of the finished belt.

Fold each strip twice so that it is a third of the original width. As shown in Fig. 2 below, a narrow strip of tin may be folded inside the strip and afterwards pulled out, to keep the width uniform. Press each strip down perfectly flat and hang it up to dry.

The pieces may be brilliantly colored by drawing them through a folded sponge slightly moistened with either water or spirit dye. The kind sold in small envelopes for dyeing clothing is satisfactory. Each belt is woven from either seven or nine of the strips, according to the width desired, so numerous color combinations are possible. Gold or silver bronze may also be used effectively. After coloring, hang the strips up with push pins and give each two coats of a good spar varnish, as shown in Fig. 1. It is not necessary to wait until the last coat is bone hard all the way through—merely dry enough to be handled without sticking or showing finger marks. How a seven-strip belt is woven by the over-and-under method is shown in Fig. 3. Each strip is given a sharp fold as it reaches one side of the belt so as to return it to the other side. After each few inches of the belt are woven, place them under weights so that the varnished surfaces will weld together.

Fig. 1. Two coats of varnish are applied to the strips after they are folded and dyed

A tongue for the belt and a piece for fastening it to the buckle are made by gluing up five or six strips of wrapping paper with waterproof casein glue and allowing them to dry while clamped between two boards. After they have been given two coats of varnish, they can be glued down as shown in Fig. 4.

Fig. 3. A belt of seven strips is shown below in the course of being woven. A simple over-and-under weave is used throughout

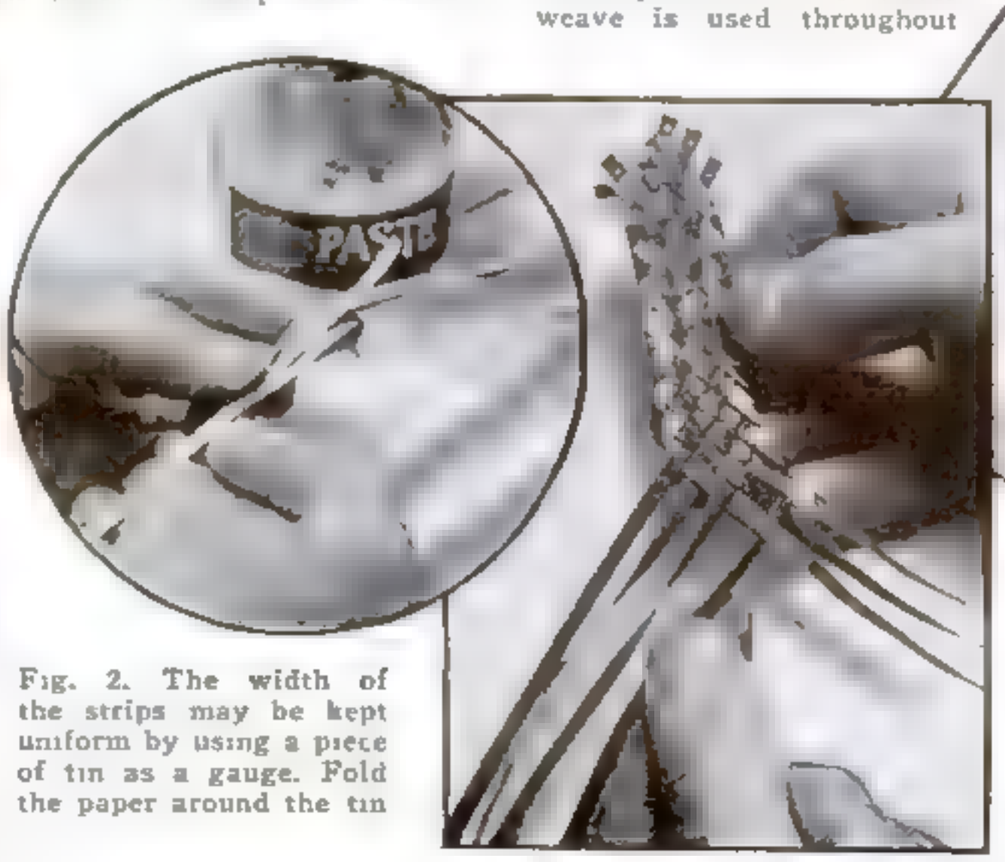
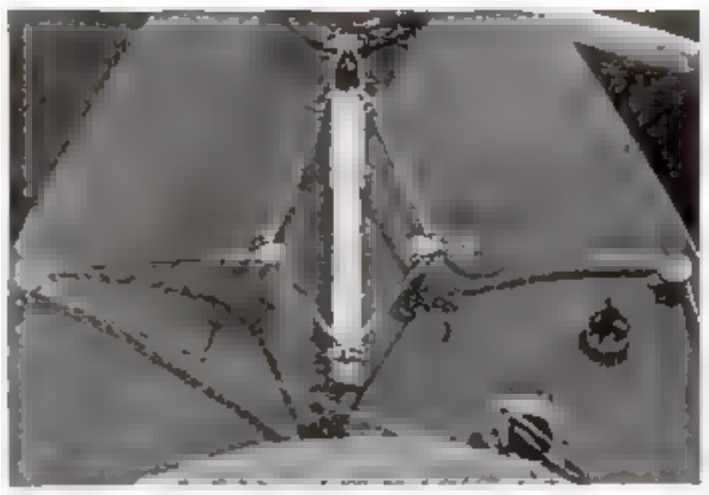


Fig. 2. The width of the strips may be kept uniform by using a piece of tin as a gauge. Fold the paper around the tin

Fig. 4. Five or six strips of wrapping paper glued together are used for the tongue and to fasten on the buckle. Punch holes in the tongue

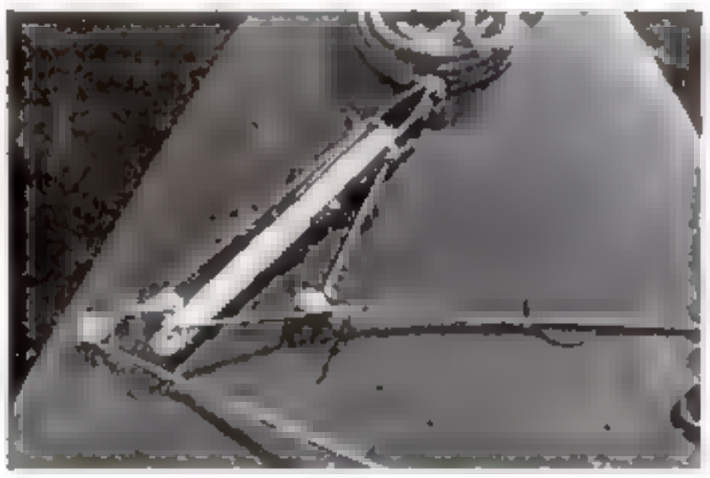
BETTER WAY TO HOOK UP SMALL BOAT'S TILLER



The tiller ropes are fastened to two small pulleys that run along short pieces of rope

THE greatest disadvantage of the ordinary system of rope-and-tiller steering for small boats is the tendency of the ropes to slacken considerably when it is least desired, that is, when the rudder is put hard over to one side. The photographs illustrate a system that completely eliminates that tendency. It is so simple to install that very little time or effort is needed to make the change.

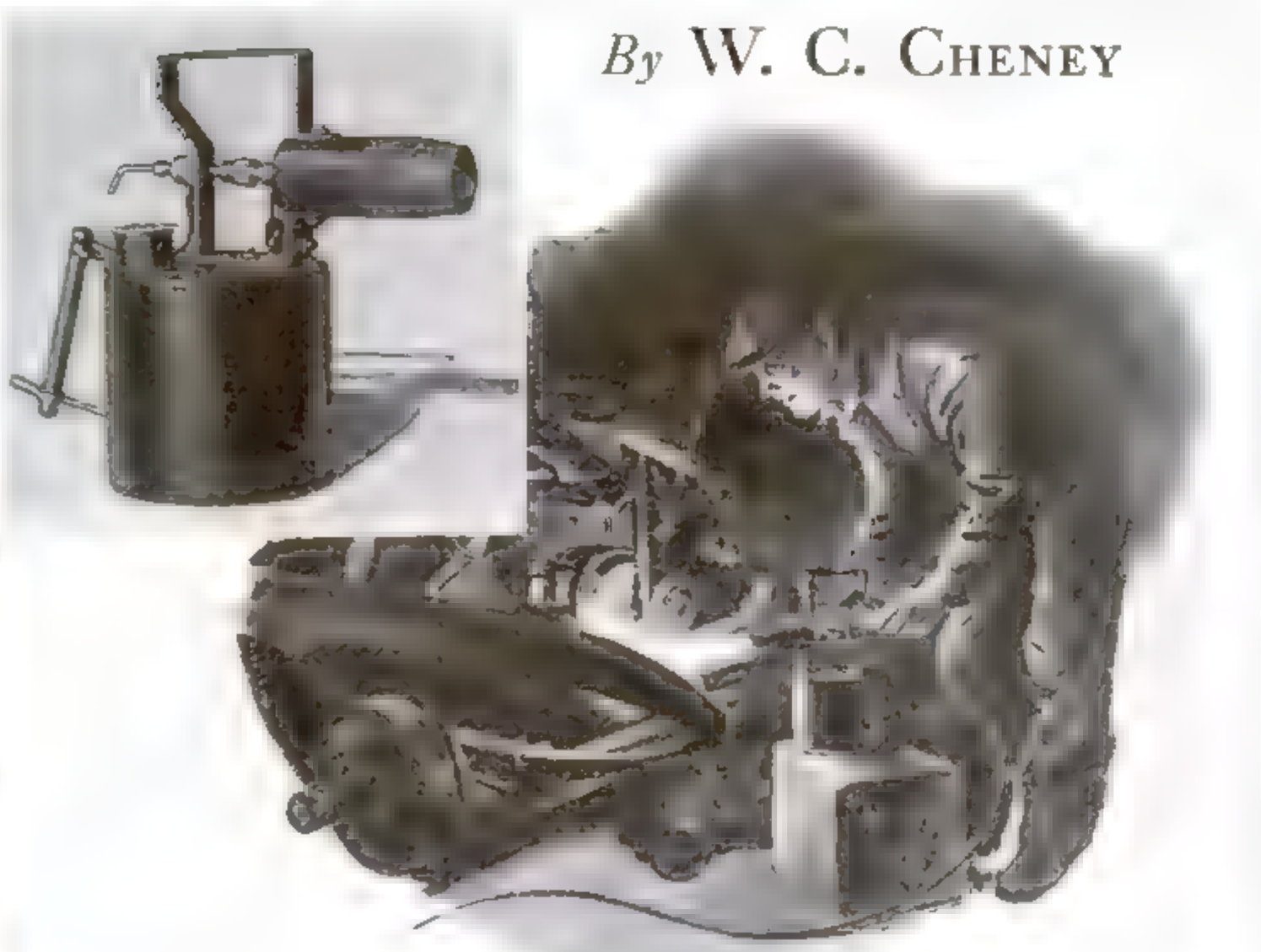
Instead of being fastened to the end of the tiller, the tiller ropes are fastened to two small pulleys that run on short pieces of rope joining the ends of the tiller. As the tiller moves to one side, the pulley on that side moves out toward the end of the tiller, while a knot in the rope prevents the other pulley from moving toward the rudder stock and slackening the tiller ropes. Since the tiller ropes remain at all times in the straight line joining the deck pulleys, the effect is very nearly the same as if a steering quadrant were used.—GUY A. RAFUSE.



Even when the rudder is put hard over, the tiller ropes have no tendency to become slack

EASILY MADE V-BLOCK FOR DRILL-PRESS USE

A SECTION of 2 by 2-in. angle, welded to the back of a piece of 8-in. channel, makes an excellent jig or V-block for use in drilling holes through round stock at the drill press, as shown above.—JOSEPH C. COYLE.



By W. C. CHENEY

SHOPMADE

Air-Diesel Torch

GIVES INTENSE HEAT

FOR safety, economy, ease of construction, and intense heat the air-Diesel torch has much to recommend it. The one illustrated uses about 1 gal. of Diesel or stove oil an hour, and the air supply may be almost anything that will supply a pressure of from 40 to 300 lb. per square inch through a 1/16-in. hole. The torch carries no fuel under pressure, has no insurance restrictions, cannot explode, starts without generating, and if the heat is confined, will melt cast iron. The flame may be regulated from a small flame for heating a soldering iron to a blast 3 ft. long.

In the illustrations above, the fuel tank is attached directly to the torch. For general use, this is a convenient arrangement, but the torch may be used separately, if preferred, and a suction hose provided to supply the fuel. When the burner alone is used in this way, it will lift the fuel about 4 ft., although for best operation the fuel supply should be only slightly below the burner level.

Whether the torch is used separately or not, the burner construction is the same. The drawings give the details. Best results will be obtained if the dimensions of the mixing valve and burner are followed exactly; dimensions not noted on the drawing, however, are not vital and may be left to the judgment of the maker. The tank is a matter of choice, and no sizes are given for it.

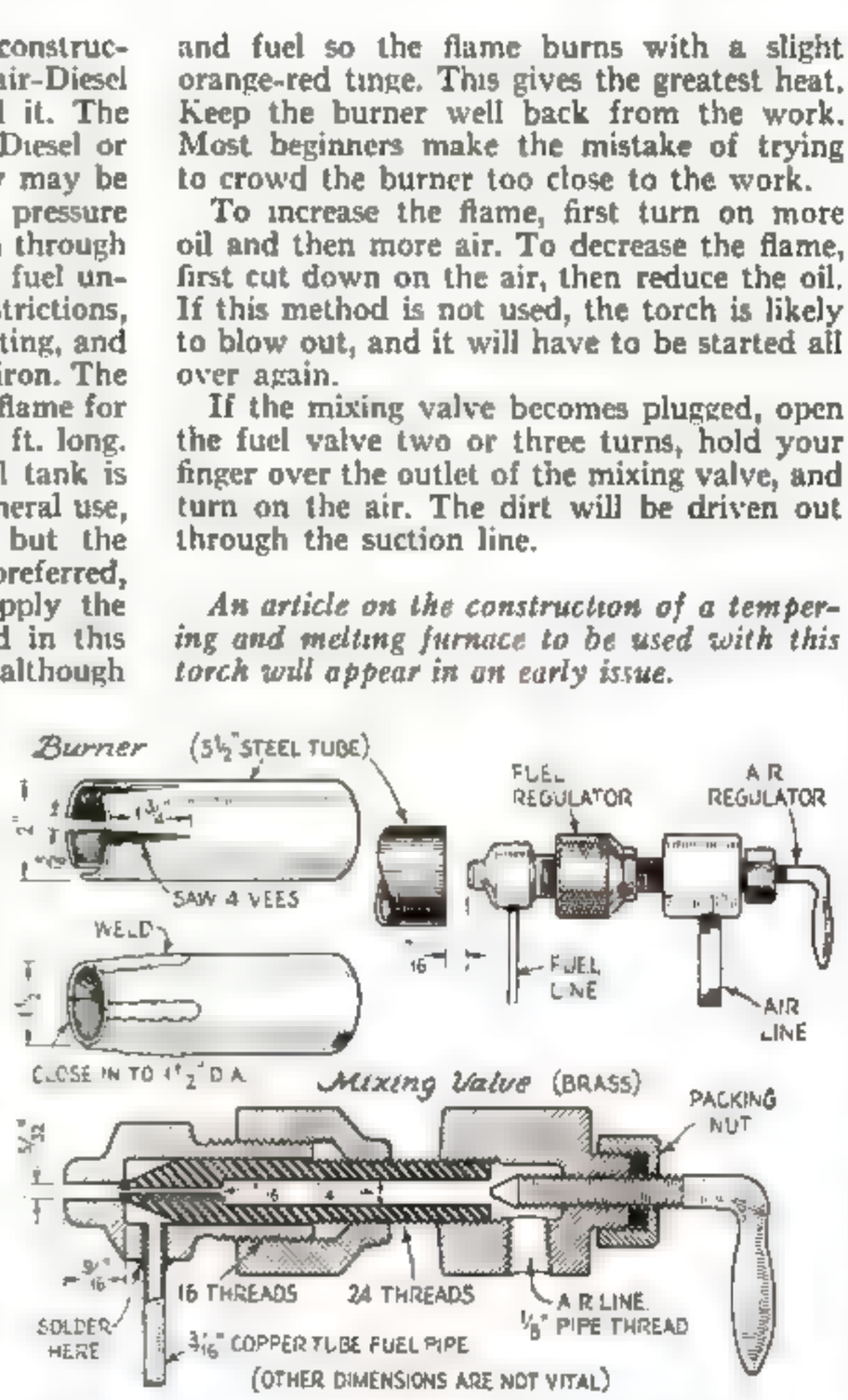
The mixing valve of the burner makes an efficient paint-spray gun for use on plain work.

To light the torch, unscrew the fuel valve about two turns, light a piece of scrap paper, crack the air valve, and when a heavy white fog starts from the burner, shove the burning paper into the back opening of the burner. Regulate the air and fuel so the flame burns with a slight orange-red tinge. This gives the greatest heat. Keep the burner well back from the work. Most beginners make the mistake of trying to crowd the burner too close to the work.

To increase the flame, first turn on more oil and then more air. To decrease the flame, first cut down on the air, then reduce the oil. If this method is not used, the torch is likely to blow out, and it will have to be started all over again.

If the mixing valve becomes plugged, open the fuel valve two or three turns, hold your finger over the outlet of the mixing valve, and turn on the air. The dirt will be driven out through the suction line.

An article on the construction of a tempering and melting furnace to be used with this torch will appear in an early issue.



Cross-section view of the mixing valve, sketch of burner tube, and diagram showing space to maintain between them

FINISHING FURNITURE AND WOODWORK

(Continued from page 66)

to do some experimental work in order to get the right amounts of red, yellow, orange, and black to produce the correct shades on the woods you use.

In either case, for your own reference you should have a set of color matches made up on the woods which you use for making furniture. About 6 by 18 in. is a good size. These should be nicely sanded, then marked off into four sections each. Use the standard 4-oz. color solution on the first section, preferably the bottom. Wash out the brush in hot water, wipe dry, and use to apply the next color, which should be made from the 4-oz. solution reduced to the proportions of 3 oz. of color to a gallon of water. Measure accurately and repeat for each section, reducing each solution as required. This then will give you four solutions and four shades from light to dark. When the match panels are finished with varnish and rubbed, as will be explained in articles to follow, they will provide an adequate guide for getting out colors suited to your new cabinetwork.

THE stain should be applied preferably with a brush of the so-called "rubber-set" type, which has been previously used for some time in varnish. The bristles in such a brush are "satisfied" with varnish in that their internal structure is well filled with the material and hence will not absorb water from the stain solution. Before using such a brush in stain, it should be cleaned with varnish remover, then turpentine, then denatured alcohol, and finally in warm water and soapsuds to remove all traces of solvents. Such a brush should then be kept for water stains only and after use should be rinsed in hot water, slapped into shape against the side of the sink while being held bristles down, and then hung up to dry. Afterwards it should be laid away in the storage cupboard in such a manner that the bristles are not allowed to get out of shape.

As in the case of most mechanics who have learned to invest in high-grade tools for the production of quality work, so too have Guild workers realized the value as well as the necessity of buying good brushes and then taking care of them. First of all, deal with a firm that sells quality paint-shop supplies and has a reputation to maintain, for in the brush business, as in few others, there is no limit to which quality can be sacrificed and still make something that looks like a brush. Ask the salesman to recommend a brush the firm will guarantee to be of good quality and manufacture. Buy the "rubber-set" grade and avoid brushes with cheaper "fillers." Ask for an all-bristle brush free of "butt stocks," as they are known in the trade. A real bristle consists of the butt, stalk, and the flag or tip, so called because in first quality bristles it is split naturally and is of prime importance in doing good work. With the less expensive bristle or cheaper grades of brushes, a few tips with good flags will be used around the outside of the brush while a mixture of lower grade bristles, or even butts cut from stock too long to be practical for some other brush, will be used to make up the weight and bulk of the brush.

FOR average use in both home and shop, an XXX black China bristle, full-chisel, varnish-flowing brush, either flat or oval, is considered practical. For turned work, as chair and table legs, where the stroke is around the leg rather than lengthwise, a single-thick, varnish-flowing type of fitch, bear, or oxhair brush is to be preferred. Brushes come in single, double, and triple-thick ferrules, depending on the size and use to which they are to be put. *(Continued on page 87)*

Old Bill SAYS:

IF YOU chill a warm high-speed drill point with cold lubricant, you're in for trouble.

* * *

You can use a common twist drill on aluminum. However, the point should be ground to a 140-deg. included angle and the cutting edges stoned slightly. The speed must be 25 percent more and the feed 25 percent less than for steel. If you order a drill to be used on aluminum, you will see that the helix angle will be twice that of an ordinary drill.

* * *

By transferring the magnetic chuck of a medium size surface grinder to a milling machine, the labor time of many jobs may be cut in half.

* * *

To obtain a fine cylindrically ground finish on copper, open the wheel grain freely with a diamond tool and fill the pores by pressing a cake of paraffin against the wheel face. Above all, use an ample flow of coolant.

* * *

For cutting threads it is advisable to grind two tool bits as twins and use a holder made so they can be interchangeable. If one breaks, the other can be quickly used without affecting the set-up.

* * *

A babbitting mixture that will resist a high degree of heat is made as follows: Fire clay, 4 parts; iron filings (finely sifted) 2 parts; peroxide of manganese, 1 part; plumbago, 1 part; sea salt, ½ part; and borax, ½ part. Work to a stiff paste and use immediately before pouring.

OUR BLUEPRINTS INSURE SUCCESS

TO AID you in your home workshop, POPULAR SCIENCE MONTHLY offers blueprints for a number of tested projects. The following is a representative list, but many other subjects are available. You can obtain a complete list by sending a self-addressed, stamped envelope with your request.

A new blueprint available this month gives full-size drawings for a model of a harbor tugboat 11⅛ in. long, the scale being ⅛ in equals 1 ft. Another blueprint contains plans for a miniature water-line model of the same tug 5 3/16 in. long and a barge 7 3/16 in. long so that a pictorial set-up may be made with the little tug towing the barge.

SHIP AND COACH MODELS

{Construction kits are available for some of these models. See page 6.}

Battleship—U. S. S. *Texas* (3-ft hull), *197-198-199-200*	1.00
Clipper Ship *Great Republic* (31½-in. hull), *272-273-274-R*	1.25
Clipper Ship in a Bottle, *121-122*	.50
Constitution (21-in. hull), *57-58-59-R*	1.00
Cruiser *Brooklyn* (8-in.), *236*	.25
Freighter, Ocean (14-in.), *271*	.25
Galleon *Revenge* (25-in.), *206-207-208-209*	1.00
Hartford, Farragut's Flagship (33½-in hull), special prints *221-222-R*	1.50
H. M. S. *Bounty* (8½-in. hull), *254*	.25
Mayflower (17½-in. hull), *83-84-85-R*	1.00
Motor Boat, Working Model (20-in.), *196*	.25
Nourmahal, power yacht (8⅛-in.), *276*	.25
Liner—*Aquitania* (9-in.), *225*	.25
Liner—*California* (12½-in.), *251*	.25
Liner—*Normandie* (20⅝-in.), *264-265*	.50
Liner—*Queen Mary* (10¼-in.), *283*	.25
Pirate Felucca (20-in.), *44-45-R*	.75
Privateer of 1812—*Swallow*, a Baltimore clipper (13-in. hull), *228-229-230-R*	1.00
Santa Maria (18-in. hull), *74-75-76-R*	1.00
Stagecoach with Horses, *144-145-146-R*	1.00
Steamboat, Mississippi (19½-in.), *94-95-96-R*	1.00
Trading Schooner (17½-in. hull), *252-253*	.50
Tugboat, Harbor (11⅜-in.), *284*	.25
Tugboat, Water-Line (5 3/16-in.) and Barge (7 3/16-in.), *285*	.25
Viking Ship, (20½-in.), *61-62-R*	.75
Whaler—*Wanderer* (20½-in.), *151* to *154*	1.00
Yacht *Rainbow* (7½-in. hull), *233*	.25
Yacht (20-in. racing), *48-R*	.50

RADIO SETS

All-Wave Portable (battery), *217-R*	.50
Amateur Short Wave Receiver, *155*	.25
Amateur Radio Transmitter, *183-184*	.50
Five-Tube Short Wave (A.C. or D.C.), *223*	.25
Full Electric Headphone Set, *130*	.25
One Tube (battery operated), *103*	.25
Screen-Grid Set, *109*	.25
Short-Wave Converter Unit, *137*	.25

FURNITURE

Coffee Table with Spiral Legs, *245A*	.25
End Table, American Empire, *241A*	.25
Fireside Seats (wood and metal), *266A*	.25
Floor Lamp with Tripod Base, *243A*	.25
Hanging Wall Cabinet, Colonial, *280A*	.25
Lamps, Three Modern, *93*	.25
Magazine Rack, Ladder-Back Style, *250A*	.25
Mirror Frame, 20 by 30 in., *246A*	.25
Sewing Cabinets, Two, *31*	.25
Smoking Stand, Modern, *238A*	.25
Stool, Scoop-Seat, *242A*	.25
Stool, Upholstered, *240A*	.25
Table, Four-Leaf Card, *239A*	.25
Tables, Tile-Top, *249A*	.25
Tavern Table and Scroll Mirror, *105*	.25

MISCELLANEOUS and TOYS

Doll's House, Colonial, *72*	.25
Doll's House, Furniture, *73*	.25
Hand Loom, Four-Treadle, *268A-269A*	.75
Microscope Kit, Portable, *220*	.25
Perpetual Star Chart, *214*	.25
Projector for Photos and Pictures, *259A*	.25
Toy Birds and Animals, Jig-Sawed, *56*	.25
Toy Drill Press, Lathe, Saw, etc., *113*	.25
Toy Dump Truck, Fire Engine, etc., *101*	.25
Weather Vane, Ship Model Type, *66*	.25

BOATS

Camper's Boat, 11 ft. 2 in. long (can be rowed or used with outboard), *281-R*	.50
Canoe, 16-ft. Canvas-Covered Kayak, with sail, etc., *192-193-194-R*	1.00
Duck Boat, Canvas Covered (13 ft. 6 in. long; weighs 60 lb.), *279-R*	.50
Duck Boat, Folding, (13-ft.), *170-R*	.50
High-Speed Boat for Small Outboard Motors (7 ft. 11 in. long), *257*	.25
Installing Inboard Motors, *270*	.25
15½-ft. Runabout or "Sportboat" (outboard or inboard motor), *175-176-177-R*	1.00
13-ft. Utility Rowboat (can be sailed or used with outboard motor), *224-R*	.50
13-ft. Racing Runabout, *261-262-R*	.75

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FINISHING FURNITURE AND WOODWORK

(Continued from page 85)

For wide surfaces, as table tops, it is advisable to have at least one 3- or 4-in. brush of a good quality grade. Small brushes do not cover the work fast enough to be practical with modern quick-setting finishes.

The purchase of quality brushes demands good "keepers." Two types are illustrated, one which can be designed by the Guild worker himself once the principles are understood; and the other type can be revamped from vegetable cans which have been cut open with a rotary can opener. In each case the brush must be suspended in such a manner as to have the bristles at least an inch above the can bottom.

YOU have perhaps been told emphatically that a varnish brush should be washed out in turpentine after use and then set away on the shelf because the bristles will be injured if it is preserved in a liquid keeper. The fact is, however, that under modern conditions, when nearly all varnishes are of some form of the four-hour type, oxidation of the traces of varnish which remain in a brush, even after it has been carefully cleaned, takes place very rapidly and the brush will become partially "seedy," as the brush hand calls it. A brush "keeper," properly built and kept clean, will preserve the brush in perfect shape. I have had brushes under test in keepers for twenty years. Two have white Russian bristles and for spreading enamel today are priceless. Another has spread color varnish on over 500 cars, and while worn down about ½ in. is still a much prized brush for many kinds of difficult work on broad surfaces.

New varnish brushes should be dry cleaned with the fingers and some form of dry duster like a new scrubbing brush; washed well with turpentine, and then suspended in a mixture of half slow-drying varnish and half pure turpentine. Kept in this manner, they are in ideal condition for the application of finishing materials. The turpentine-varnish mixture should be kept at a level halfway up on the metal ferrule of the brush so that any traces of hardening of varnish may not take place on the brush itself and then be worked off into the new finish coat.

AT NO time should a brush of any type be suspended in water, for to do so will cause the bristles to get soft and flabby with entire loss of springiness, and in addition may so swell the plug in the base of the ferrule as to split the latter and ruin the brush.

Paintbrushes may be kept suspended in a mixture of turpentine and raw linseed oil, although the best medium in which to store them continuously, I have found, is either pure pine oil or half pine oil and half raw linseed oil. Shellac brushes should be washed out with denatured alcohol and then laid away on the shelf until needed.

Sometimes brushes left on the shelf get hard because of careless cleaning. Do not try to soften them by bending with the fingers; to do so will break a number of bristles, and these which will work into the new coating of finish and cause a lot of trouble. Soften the brush in either turpentine or alcohol, depending on what the brush was used in the last time.

Make up your mind to buy good brushes and then take care of them. When you use them, remember the paint-shop rule for the order in which to finish the various surfaces of any project:

"Start with that which you see the least,
End with that which you see the most."

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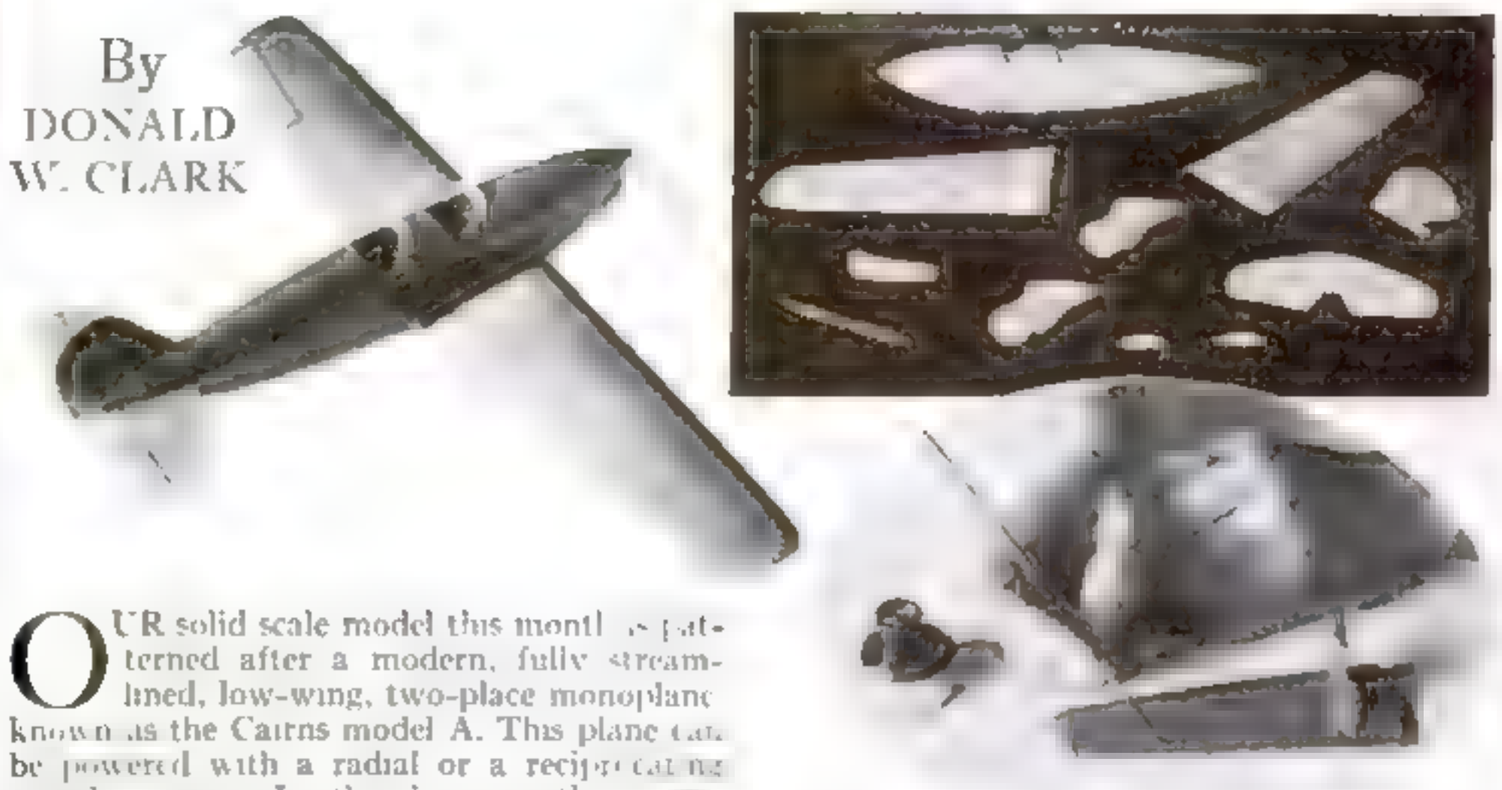
Only eleven parts needed for this

Streamlined Plane Model

By DONALD W. CLARK

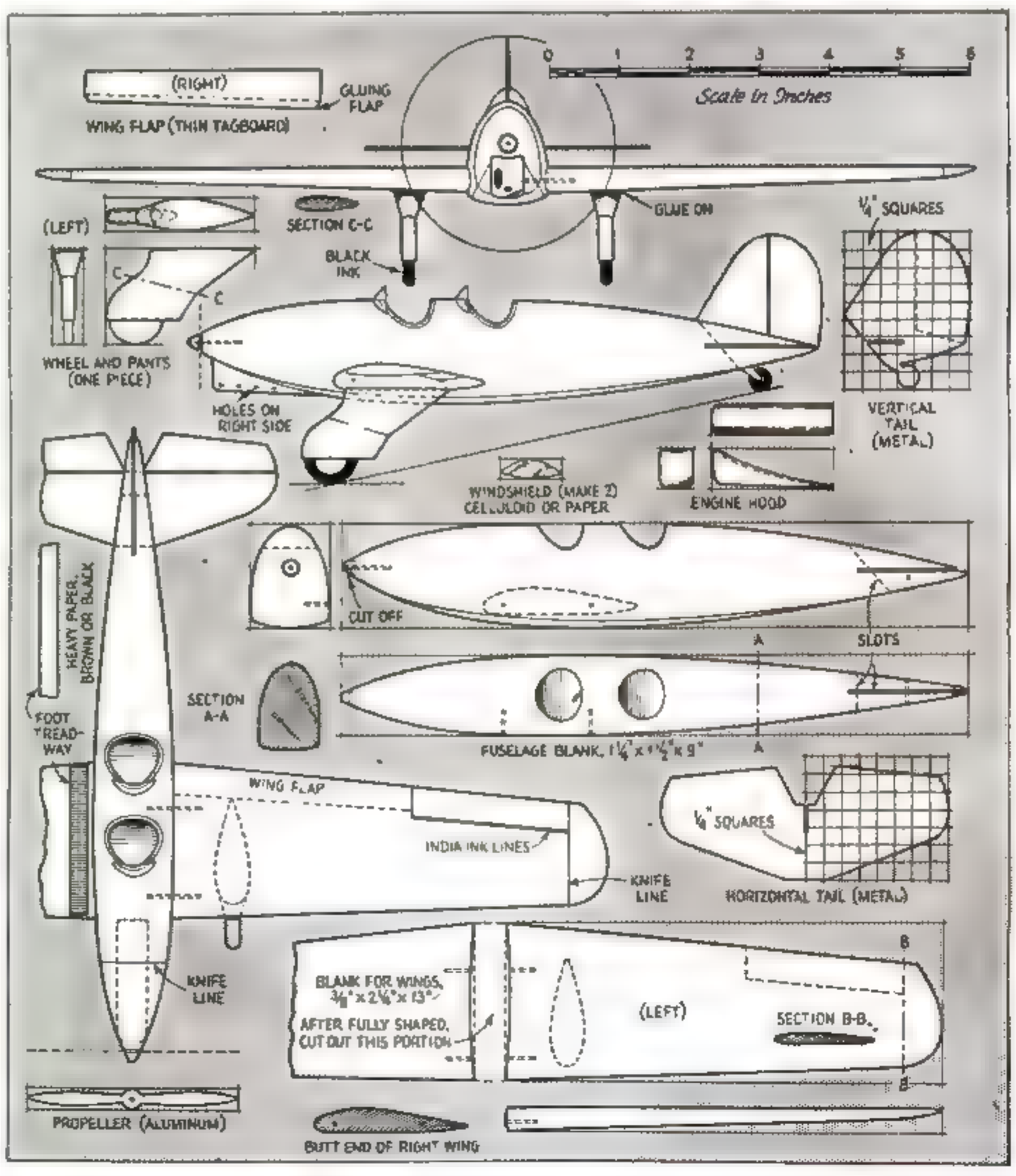


OUR solid scale model this month is patterned after a modern, fully streamlined, low-wing, two-place monoplane known as the Cairns model A. This plane can be powered with a radial or a reciprocating upright engine. In this instance the power plant is an inverted Menasco engine.

At 2,000 ft. this ship is rated as having a high speed of 190 miles per hour and a cruising speed of 160. The general specifications are: span, 36 ft. 6 in. Length over all, 24 ft. 7 in. Height over all, 7 ft. 6 in. Wing area, 101 sq. ft.

This model is built to the scale of ⅜ in. equals 1 ft. in comparison to the real plane. Only eleven parts are required.

Wing flaps are optional equipment, so they are shown in the drawings in case the builder desires to add them. The color scheme is dark and light green with black trim.



Working drawings of the model with sizes of the fuselage and wing blanks and a scale in inches for finding other necessary dimensions. The photos above show the parts and the finished model

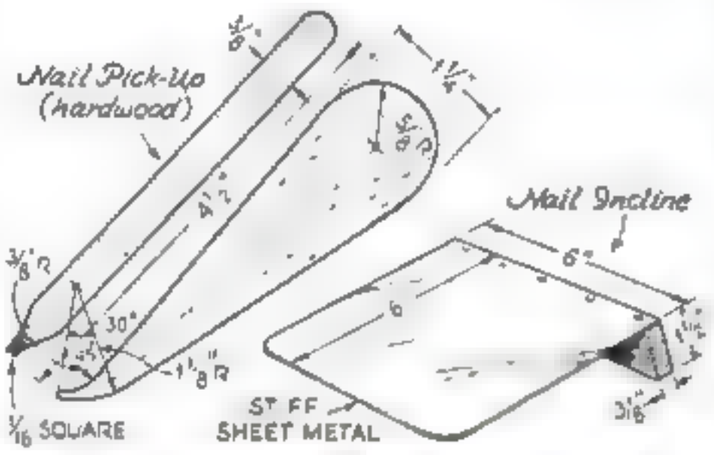
A PICK-UP FOR DRIVING SMALL BRADS QUICKLY

Beeswax on the end of a small stick holds the brad upright while it is being driven

TINY brads are bothersome to handle, and if they are as short as ¼ in. in length, they are likely to arouse the ire of the most patient man. It is true that they can be held for nailing with tweezers or small pliers, but the work goes slowly. A magnetic hammer is effective if the brad need not be located precisely, and if the head of the tack, rather than the point, happens to attach itself to the face. This tool, of course, cannot be used with nonferrous nails.

The photographs show an easy method of driving very small nails quickly and accurately. Shape the pick-up tool as shown in the drawing, round the corners for comfort, and press a bit of beeswax on the notched tip. Also nail a 6-in. square of stiff sheet metal to a strip of wood, forming an incline to be placed at the left of the work.

With the left hand, shake a few nails from the container onto the sloping metal. They will instantly roll around until all the heads are downward, thus bringing them parallel. Now, holding the pick-up vertically, press the wax against a nail. The nail will stick and can be easily lifted and placed at the exact point where it is to be driven. After a little practice, the brads can be driven quite rapidly by this method.—EDWIN M. LOVE.



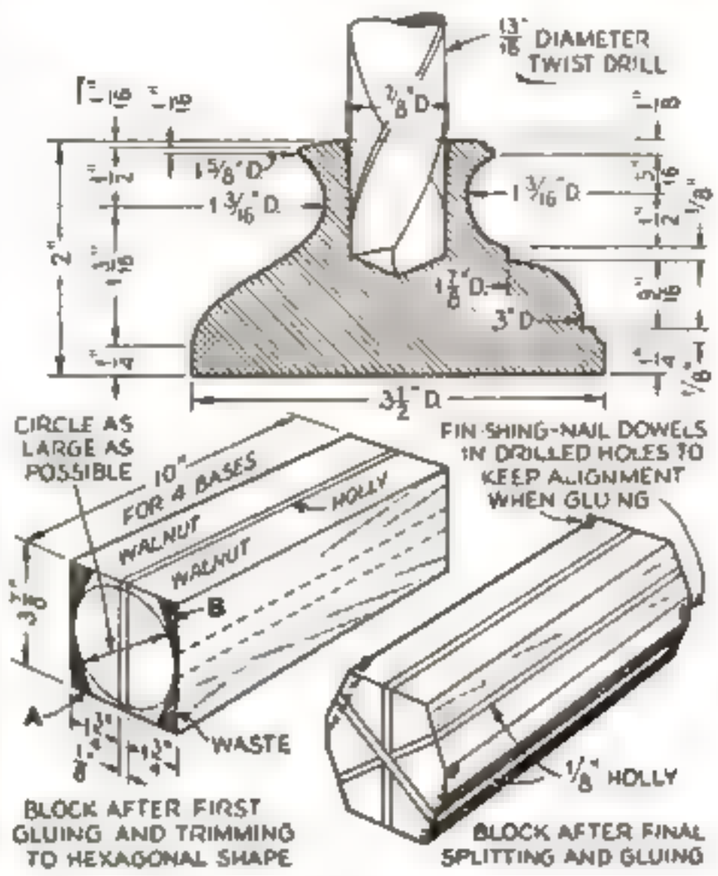
The nails roll with heads downward so that they can be picked up by means of the stick

TURNED CANDLE BASES

(Continued from page 60)

piece as shown in one drawing below.

Center the glued-up block accurately in the lathe at the intersection of the holly strips and turn to 3½ in. diameter throughout. Turn to shape and sand all four bases. Then saw them apart and mount individually in a soft pine chuck bored ¼ in. deep to a tight



A section of the turned base, showing two good profiles; and method of gluing the block

fit on the 3½-in. diameter. Drill the candle holes with a 13/16-in. twist drill mounted in the lathe tailstock.

For applying the lathe finish, mount each base on a 13/16-in. diameter plug chuck entered into the bored hole. Run in the tail center to steady, if necessary. Fill the grain with white shellac rubbed on with a little oil. Remove for varnishing and afterwards glue felt on the bottom.

POCKETKNIFE CUT FROM ONE PIECE OF WOOD

(Continued from page 69)

Fig. 16, shows what such a knife would look like if taken apart, and the cross section of Fig. 17 shows how the pivot fits through the second, and smaller, blade. In principle, this joint is exactly like the other ones, except that the pivot is made longer on one side to go through the second blade as well as the side of the handle.

A simple pattern for a knife of this type is given in Fig. 15. You'll need a piece of wood ½ in. by ¾ by 5½ in. Work just as you did in making the smaller knife, but make the blade blank much thicker (5/16 or ⅜ in.), and don't shape it before freeing the pivot.

A knife and its copy in wood, and a larger knife with two blades working on one pivot

Cut in around the pivot as before and free the blade butt, then go to work around the pivot, cutting in the V still deeper on one side, as in Fig. 17, until the pivot is free deeply enough in the blade butt to permit the second blade to be split free. Now, unless the grain in the blade is unusually straight, you had better saw down from the tip of the blade to the butt about a full 1/16 in. in from the side where the pivot is cut in deeply. Then split through the blade butt with your knife and shape up the smaller blade. (It is best to make one blade smaller than the other for effect.)

If you wish, you can put another blade on the other side, or shape a blade on the other side into a finger-nail file, or even make a little pair of shears of it, using either the pivot principle or the familiar plier joint such as is used in wooden pliers. If you use a pivot, you will have to make it with a head larger than its stem—in other words like a countersunk-head rivet, a job that is quite difficult. Also, the pivot principle can be used in making a wooden razor (easier because a razor has no backing spring) or any other piece that has a similar joint.

A COLONIAL CABINET

(Continued from page 61)

the cabinet has been otherwise completed.

An attractive color effect may be obtained if the inside of the shelving section is painted ivory or even a slightly neutralized vermilion color.—FRANKLIN H. GOTTSHALL.

List of Materials

Description	No. Pcs.	Size
Legs	4	2 x 2 x 20½
Ends of lower section	2	¾ x 8½ x 20½
Back of lower section	1	¾ x 15 x 20½
Rail at bottom of cabinet	1	¾ x 2 x 16½
Rail above door	1	¾ x 2 x 16½
Floor of cabinet	1	¾ x 10½ x 17
Stiles in door	2	¾ x 2 x 17¾
Lower rail in door	1	¾ x 2½ x 13
Upper rail in door	1	¾ x 4 x 13
Panel in door	1	¾ x 11¼ x 15
Feet	4	3 diam. x 4¾
Sides of shelves	2	¾ x 10⅝ x 40
Shelves	4	¾ x 10¼ x 15¼
Roof	1	¾ x 10⅝ x 15¼
Pediment	1	¾ x 7½ x 18
Finial	1	2 diam. x 6
Back of shelves	1	plywd. ⅜ x 15¼ x 39
Drawer front	1	⅝ x 4 x 14½
Drawer sides	2	⅜ x 4 x 9⅝
Drawer back	1	¼ x 3½ x 14⅛
Drawer bottom	1	plywd. ¼ x 9½ x 14⅛
Molding		Consult drawing

NOTE: All dimensions are given in inches and represent finished sizes.

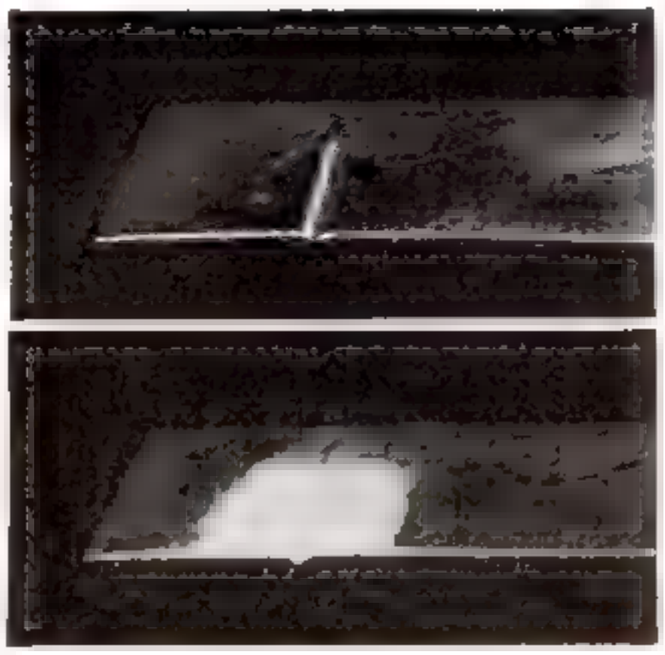
STEEL WOOL MAKES SCREWS HOLD BETTER IN PLASTER

EFFORTS to drive screws into a plaster wall generally result in a badly cracked wall. In the absence of proper plugs or toggle bolts, drive the screw into the wall, first making a hole with a nail. Then remove the screw and fill the hole with steel wool. When you drive the screw into the steel wool, you will find that it will hold securely, even under heavy weights.—JOSEPH PETR

EASILY HOOKED TRAILER CHAINS

HEAVY harness snaps on the car ends of trailer chains make them easy to hook to a car and as equally easy to take off. Let the chains cross under the trailer tongue so that if the hitch fails, the tongue will drop down on the chains and the trailer will still be under control.—P. McD.

TIPS ON THE WELDING OF AUTO FENDERS



How crack in fender steel is prepared, and the same piece after being welded. Note the smooth top and the reënforcement underneath

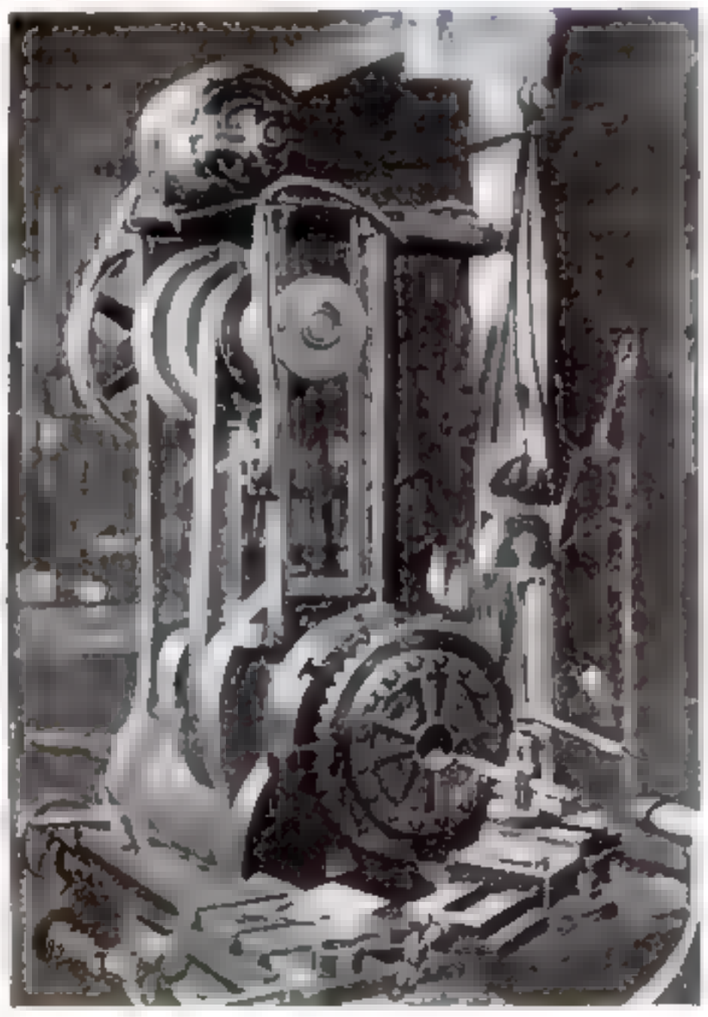
WHEREVER practical, automobile fenders should be welded and not brazed, as the phosphorous and sulphur in the brazing rod is likely to cause the steel to crack, often before the job is cold.

When welding, start at the inside of the crack and work to the edge. This will frequently save an unsightly bump and a job of shrinking after the weld is complete. If a thin fender is to be welded to a thick brace, one may save a lot of difficulty by placing a piece of copper tight against the fender. This will conduct the heat away from the thin fender material and allow the heavier brace to be brought to welding temperature without burning the fender. It is advisable to use a small filler rod when welding fenders so the material will not be burned.—W. C. C.

COMPACT MOTOR DRIVE FOR SHOP MACHINES

AN UNUSUALLY compact, efficient, and inexpensive drive for shop machines is shown in the accompanying illustrations. This set-up has been used in my own shop with gratifying results, so I do not hesitate to recommend it. By degrees I am revamping my shop throughout in the same way and expect to save much time and expense.

The photographs *(Continued on page 93)*



The drive used on a 18-in. lathe. Even the step pulleys and knife switch are home built

TRANSFORMER FOR PHOTOFLOOD LAMPS

(Continued from page 78)

points is stored at each end during the winding process.

Start the winding at the left end of the form. Tie the end of the wire around the shaft outside the form, thread the wire through the slot in the end piece, and wind on 40 turns. Take the wire through the slot in the right end of the form, twice around the shaft, and back through the slot. This is the 120-volt tap. Continue the winding for 20 more turns and take out another tap, which should be marked in some way because it is one side of the 115-volt line winding. Now wind on 20 more turns and take out a tap, which will be the 110-volt tap. Continue winding 40 more turns and taking out taps for each 10 volts down to zero, which tap will also be the other side of the 115-volt line winding. From this point on, taps are taken out every 4 turns and constitute the 1-volt taps from 0 to 9, which is the end of the coil. As the coil is wound, each layer of wire should be given a coat of orange shellac, and the outer layer should be given an extra thick coat of orange shellac. The whole winding should then be laid away to dry for about twenty-four hours.

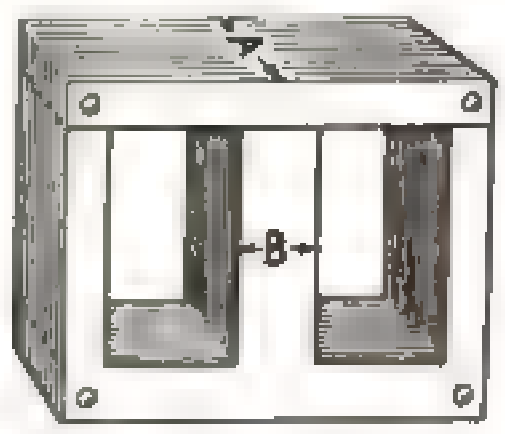


Fig. 5. A radio transformer provides the core

When thoroughly dry, the winding should be removed from the form, and the core reassembled by sliding the center leg of the W-shaped pieces of iron through the winding alternately from opposite ends of the coil. The I-shaped pieces of iron are placed at the ends to complete the magnetic path. When all of the iron is in place, small wooden wedges may be inserted between the core and coil if it is found necessary, and the whole core clamped together and mounted.

The method of mounting depends entirely upon the desires of the builder. That used by the writer is shown in Fig. 3. The assembled coil is mounted on a composition panel through which are also mounted the terminals, which in this case are the so-called "banana plug and jack combination" obtainable at radio service shops. These are placed in two rows, one for the 10-volt taps and one for the 1-volt taps. Two plugs are provided for the output leads. The connections are made as shown in the wiring diagram, Fig. 4. The start of the winding is connected to the 130-volt jack, the first tap to the 120-volt jack, the second tap direct to one side of the line only, the third tap to the 110-volt jack, and so on. The tap at the end of the last 40-turn coil is connected to the zero jack and the opposite side of the line. The 4-turn coils are connected to the 1-volt jacks 1 to 9 respectively.

It will now be seen that the 115-volt line winding is fixed and connected to the input plug mounted on the face of the panel. The output voltage is variable in steps of 1 volt and is connected through the flexible leads to the output socket. To obtain a potential of 5 volts, for example, the plugs are inserted in the jacks 0 and 5, whereas if a potential of 122 is desired, the plugs are inserted in jacks 120 and 2, and so on for any voltage up to 139 volts.

It is not intended that any photoflood lamp should be operated at the voltages above 115, but the higher voltage taps are provided so that in the event a photoflood lamp is not available, a standard 115-volt lamp may be used at high voltage to produce additional illumination.

Fig. 6. With this type of winding form, it is easy to wind the coil and take off taps

Figure 1 shows the completed transformer mounted and inclosed in a wood box, but this was done to make a portable unit. If the transformer were mounted permanently without a housing, ventilation would be better, although no objectionable heating has been noted even when the transformer has supplied two No. 1 lamps for hours at a time on copy work. Figure 2 shows the device supplying an enlarger at a reduced voltage wherein it gives complete print control

The method of mounting or means of changing taps is of little importance, and the suggestions given may be modified to suit the constructor. The convenience of a source of variable voltage will, however, well repay any one who uses photoflood lamps.

SPECIAL FILM HARDENER PREVENTS SCRATCHES

THERE is one improved method of the professional miniature camera photographer and the advanced amateur that could work wonders for the average snapshot fan. It is a special short-stop bath and hardener used between the developer and the fixing bath. Not only will this stop development immediately, but it will so harden and toughen the emulsion that scratches from ordinary handling will be almost impossible; and the drying of the film, assisted by artificial heat, may be accomplished in a few minutes.

Dissolve 1/3 oz. potassium chrome alum in 16 oz. water, at temperature of the developing solution, which should best be between 65 and 70 deg. F. When this has thoroughly dissolved, add 1/3 oz. sodium bisulphite. The hardening solution should be mixed immediately before using, and discarded afterwards.

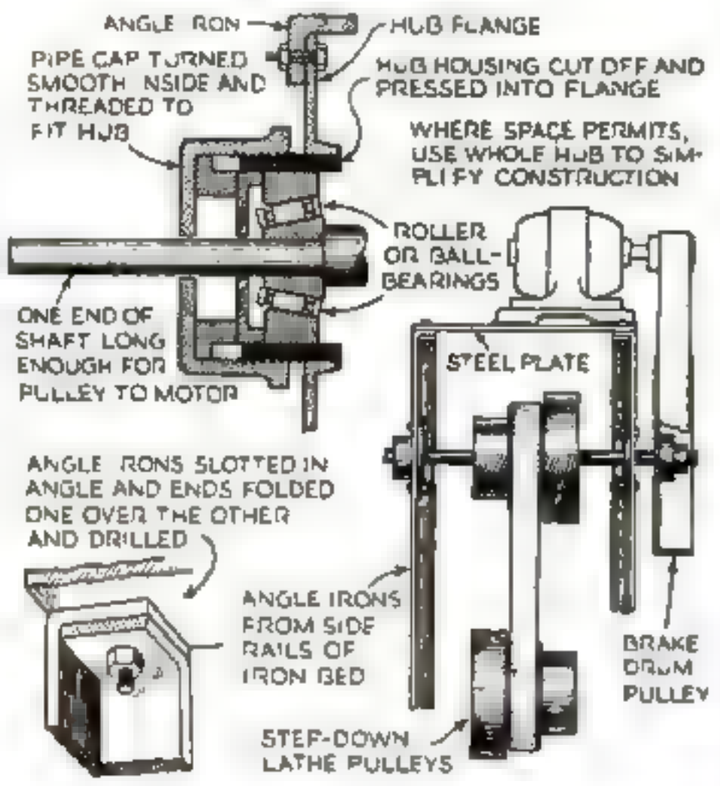
Time may be saved if the chemicals are wrapped in 1/3-oz. portions, like doctors' prescription powders, and pairs of these little packages are bound together with rubber bands.

Develop the film as usual, and, without rinsing, immerse it directly in the hardening solution. Agitate for a few seconds and allow to remain for four or five minutes. Then pour off the hardener and put the film in the fixing solution. Rinsing is not necessary at this point, but may be done if desired. Fix and wash as usual

After washing, the film should be wiped on both sides with a damp piece of cotton, chamois, or viscose sponge, to remove dirt and water spots, and placed in a current of warm air to dry. The film should be ready to put in your enlarger within from four to ten minutes.—KENNETH M. SWEZEY.

COMPACT MOTOR DRIVE

(Continued from page 91)

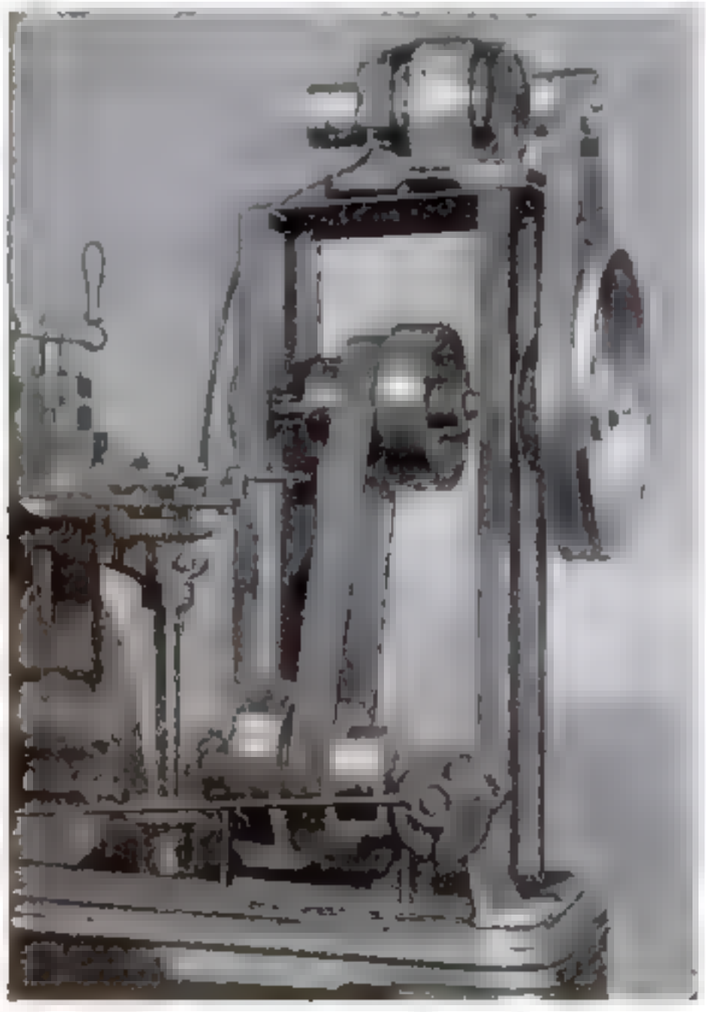


A typical shaft bearing; method of fastening motor support to angle irons; complete set-up

show the drive on a large lathe and a similar arrangement on a universal milling machine. These with the sketches are practically self-explanatory.

It will be noted that the top pulleys on the lathe drive are turned from wood. They were made in this way because no regular pulleys happened to be available. The motor is ¾ h.p. The large pulley used in driving the milling machine is an auto brake drum. The motor is 1/3 h.p. and as yet is only temporarily set up.

A single motor may be used by moving it from one machine to another, but it is better to have individual motors. The cost of this type of installation is more than offset in the long run by the saving in belts such as are required in the usual line-shaft arrangements still found in many small shops.—ANTON HECKEL.



Universaal milling machine with individual drive. The motor shown is a temporary one

EXPERIMENTAL PHOTO FILTERS

SMALL circles of colored transparent wrapping material of the cellulose type can be used as experimental color filters on your camera. Yellow, orange, red, and green are the most useful colors. For temporary use, coat the lens flange with rubber cement and immediately stretch the thin cellulose material over it without wrinkles.—K. M.

UNCLE SAM CRACKS DOWN ON SPIES

(Continued from page 13)

February 11, 1936, the Army issued minute directions for hiding its military secrets from such skulkers. Research work, designing, developing, testing, or producing of equipment can now be declared a "restricted project," and anyone who allows a foreign power to acquire improperly "any writing, code book, signal book, sketch, photograph, photographic negative, blueprint, print, map, model, note, instrument, appliance, or information" relating to such a project, may get two years in prison, while anyone who voluntarily gives or sells such information may get twenty years—in peace time. In time of war, he may face the black muzzles of a firing squad.

THE Army was shocked into issuing these drastic orders by recent events, notably the Osman case. Osman, an Army noncommissioned officer with access to important data on the defenses of the Panama Canal, was accused of sending portions of it to a mysterious correspondent. Confronted with the stern gaze of a court-martial, he was charged with corresponding under an assumed name, with foreign agents who sent him money. The court snapped "Twenty years!" President Roosevelt later ordered a retrial and Osman was acquitted, but the whole proceedings served to show the Army the danger in letting its secrets lie around loose.

Now, secrecy is enforced by restricting, for a two-year trial period, information about new military inventions like the fast, light tank that has been officially described as equal to or better than that of any nation. But to enforce silence at Fort Benning, Ga., where the 29th Infantry tries out new equipment, is not always easy. One officer lamented:

"This morning, 1,200 doughboys tried out the new semi-automatic rifle. Tonight, 1,200 doughboys keep 1,200 dates with 1,200 girls, and tomorrow night, 1,200 girls keep 1,200 dates with 1,200 foreign spies!"

Big numbers—but the tiptoe tracks of foreign spies really have been found at Fort Benning. The Army has recently ordered that before any foreigner can visit an establishment, Government or private, where the War Department wants secrecy preserved, he must get permission from the Secretary of War—and he *must not* carry a camera. That may stop the "distinguished foreign scientists," one of whom not long ago walked blandly through a munition factory, paused an instant, whisked up a corner of a vest, and photographed a machine with a tiny microscopic camera camouflaged as a suspender button.

A CAMERA'S click was an alarm that helped start the Navy hunting spies, but the camera was no miniature. Its German telescopic lens ranged a mile. Trained upon our new cruiser *Trenton*, it was gripped in the brown hands of Yoshio Matsuda, an officer in the Japanese Navy, touring American ports in civilian clothes. There was no law against it when he was arrested, last winter, but in seventy-two hours the highest strategical authority in the country, the joint Army and Navy Board, had introduced one into Congress. Now it is illegal, without permission, to sketch, map, or photograph, from ground or air, any one of twenty four Army and Navy reservations, including flying fields.

As a result partly of the Matsuda case, the Navy has revived its war-time "security service" to protect such secrets as a new process of long-distance weather forecasting. Based on astronomical computations, this process is an improvement on the system devised by Gen. A. W. Greely. Already it has predicted hurricanes. That secret is locked up, against the day it may be needed for the first sea fight of "the next war."

Also locked up in Washington is a startling preview of that fight: a sudden, lightning stab below the belt, at our battle fleet just putting to sea; by an enemy lurking in wait, disguised—a spy navy. Grotesque? Well, high Army and Navy officers do not think so. A Congressional committee has taken sworn testimony about it, with a blueprint by a Government marine surveyor, which I have seen. It shows a powerful steel clipper, with a 500-horsepower Diesel engine, high-power electric searchlight, wireless, and an 8,000-mile high-sea cruising radius. There are 250 of them on our Pacific coast, catching tuna. But the fish bins and bait tanks of many are so constructed, that they can be quickly converted into mine magazines and torpedo tubes.

MOST of those boats are owned by Japanese and manned by Japanese naval reservists. In war's first hour, they would strike at our battleships, which today the Navy is trying to strengthen against torpedoes and mines. And today, those battleships are followed about by this flitting fleet, like a spy shadowing his quarry. Sea spies hover when our Fleet has target practice, or passes through the Panama Canal. Only recently, Representative Samuel Dickstein charged in Congress that some were haunting the Aleutian Islands where our Army and Navy are making important surveys.

As the weasel-like scientific spies suck out our defense secrets on sea and land, their eyes also turn greedily toward the sky. American aviation is producing the best, and, since Congress authorized 5,000 more war planes, may soon produce the most. Recently, American ingenuity has achieved all-metal fighting monoplanes which threaten to shelve the biplane, and new, heavy passenger planes convertible into bombers or "flying headquarters." The Government is testing a new theory of propelling dirigibles by drawing in air through a funnel-like opening at the front, and expelling it from the rear, at tremendous speed.

Like honey, such inventions draw swarms of spies. Take the mystery of the vanishing airplane. Last summer, it stood ready to leave a California airport on its trial trip. Its pilot, a Reserve officer, leaned out for final instructions.

"Don't fly out of sight!" they cautioned him.

"O K!" he cried back. "Contact!"

The new plane soared, circled, maneuvered. It seemed under perfect control.

"It's a knock-out!" exulted the spectators. "It'll do 350 when he gives it the gun. Greatest fighting plane ever built. Worth the hundred thou—why—what's he doing?"

The new plane was speeding away westward. It vanished.

The greatest fighting airplane ever built has never come back. Nor has its pilot, though he had a parachute. Army and police investigated, and found this:

THE plane had been seen flying, at tremendous speed, northward along the Pacific shore. Not far out at sea, also dashing north, was a speedboat that had been seen waiting offshore.

Today, at the great military airport at Dayton, Ohio, new models are guarded by barred doors, in hangars that only officers can enter. That is one result of a recent conference at Washington on aircraft secrecy.

Really to stop the scientific spies is hard, with laws so lax that the famous G-men confess they can beat *(Continued on page 95)*

UNCLE SAM CRACKS DOWN ON FOREIGN SPIES

(Continued from page 94)

kidnapers and bandits, but not spies. Why, after a spy has stolen a secret, Uncle Sam's mail will deliver it for him, to his country's embassy or consulate here, or to some "cover" address abroad. Yet, in most countries, communication is the weakest link in the chain of secret service, And the spy *must* communicate.

Many spies use couriers, like the *Europa* steward. They devise crafty ways to conceal their precious reports, written frequently with a microscopic pen, upon gauziest tissue paper, to fill little space. They are hidden furtively in hollow or false teeth, shoe heels, the plaster casing of a broken arm, between safety-razor blades, in hollow canes, toothbrush handles, candy, tin foil around flowers. An arrested spy calmly lighted his pipe. A detective leaped upon him and knocked the pipe from his hand. Hidden in the tobacco was a tiny roll of tissue paper which the spy had attempted to destroy.

OFTEN, spy messages are in secret code or cipher. To solve one, may open a trail through the ramifications of a whole espionage system, to its directing head. At least, the system can be poisoned at the source, by sending out falsified reports. So there is a tense, hidden conflict between spy and cryptographer, that furnishes one of the most dramatic and mystifying aspects of the great game of secret service.

Safe communication is a problem so pressing that, a while back, some excellent scientific brains were set to solve it. They experimented on an invisible signaling by infra-red rays. So, at our Army's maneuvers this summer, you may stumble across a soldier, crouched on the ground, talking to himself.

"Da-da-di-da!" he says. Silence. Then a shrill whistle, shorts and longs. If you can get a good look, you will see that he is talking the dots and dashes of radio code into the microphone of a neat ten-pound portable transmitter. It transforms the sound into invisible infra-red light, and directs it to a receiver, from which it issues in long and short whistles. Infra-red beams cannot be intercepted by enemy radio.

Have we discovered the secret of secret spy communication? Already, stealthily the scientific spies are slinking, to steal it.

RARE METAL MAY FORM BETTER SURGICAL CAST

SURGICAL casts of metal may replace plaster casts, if experiments conducted by Dr. Sidney J. French of Colgate University prove applicable in practice. By combining the rare silvery metal indium with bismuth, lead, tin, and cadmium, he obtained an alloy that melts at the unusually low temperature of 116 degrees F. The figure is considered especially significant because it lies well above human body temperature but is low enough to cause no injury or serious discomfort to the skin. Cloth impregnated with the metal and used to bandage a broken limb could be manipulated after being applied. As soon as the correct placement of bones had been accomplished under the surgeon's hands, a nurse could chill the bandage, transforming it into a rigid cast of solid metal.

The present obstacle lies in the high cost of indium, but new uses being found for it are expected to stimulate its commercial production and lower its price. Indium has been found to harden copper and silver, to improve dental gold with which it is alloyed, and to show useful properties when plated over other metals. Today about four and a half tons of indium are being extracted yearly from the ores in which it occurs.

Strap-Iron Craftwork

FOR BEGINNERS

By R. H. ROSS

Curled ends are started with a wrench, then finished by bending with pliers and hammering

Graceful strap-iron bracket for supporting a vase of ivy, a flowerpot, or a fern basket

FOR home workshop enthusiasts who want to vary their usual woodworking, I recommend strap-iron craftwork. Strap iron is easy to work into practical and graceful articles such as bracket lamps, flowerpot brackets, and fern stands. Furthermore, no special tools are required, the cost is negligible, and a beginner can obtain satisfactory results at the very start. Then, if he cares to pursue the craft further, he can learn, by studying various available books and instruction sheets, the more professional methods of expert wrought-iron craftsmen

For small articles like those shown in the accompanying photographs, I have found iron strips about ⅝ by ⅛ in. to be satisfactory. With this size, many curves can be bent with the hands alone. If strap iron of about this size is not stocked by your local hardware store or tinsmith, it can be obtained from large mail-order firms or special dealers for a few cents a pound.

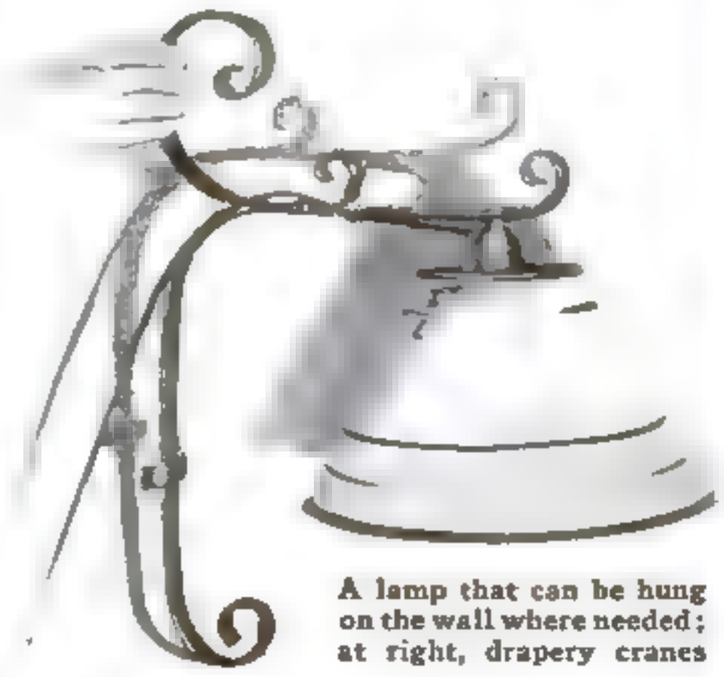
Since most articles made from strap iron depend upon graceful curves and curled ends for their pleasing appearance, these curves and curls must be correctly proportioned. The best method is to draw a full-size sketch on paper and adjust the proportions of the sketch to your satisfaction.

After the strips are cut to the desired lengths, the end curls can be made. These are easily started with the aid of a wrench, as shown in one of the accompanying photographs, and completed with a pair of pliers and by hammering

Next, the long, smooth curves are made. In doing this, care must be taken not to bend the stock too much as strap iron has a tendency to bend sharply. The solution for this condition is to bend the iron a little at a time and round out the bent places by hammering the iron over a pipe or round piece of wood.

When the different parts have been finished, they should be clamped together and drilled for rivets. The rivets can be made from nails.

If you wish to give the articles a beautiful blue-gray finish, put them into a coal furnace until red hot; then take them out and quench in water. To prevent rust, apply a coat of wax.

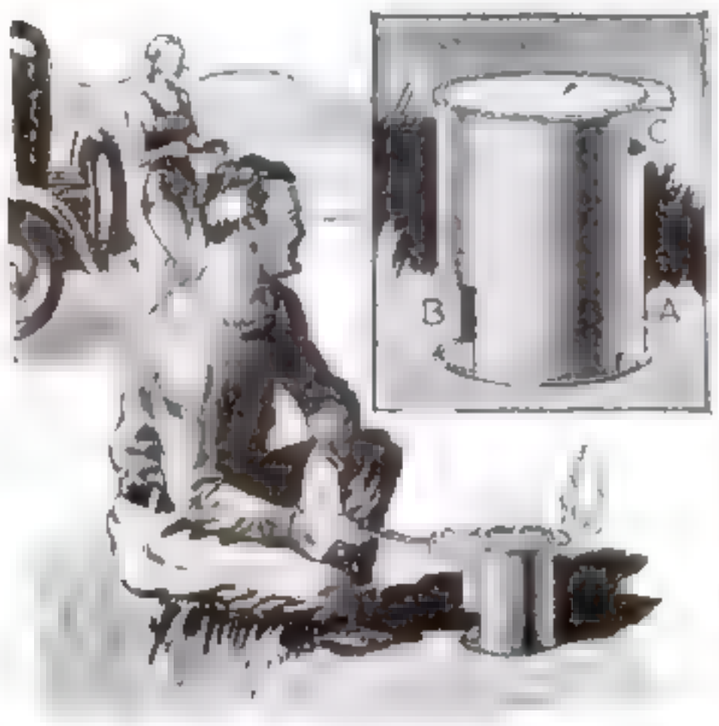


A lamp that can be hung on the wall where needed; at right, drapery cranes

CAMP AND PICNIC MEALS COOKED ON TIN CAN

AN OLD tin can is all it takes to make this camp stove, the top of which serves as a bacon, egg, or pancake griddle. It is equally useful in your own back yard, on the beach, in the woods, or by the roadside. And in any of these places, it will give you a thrill to remove steaming, golden brown pancakes from this homemade stove.

The can may be prepared at home, but if you wish to conserve space and are planning to have canned fruit for your outdoor meal, just take along a can opener and tin shears or other tool for cutting two openings in the cylindrical side of the can. A one-gallon can is the most effective, but a two-quart tin will



Wheat cakes, bacon, eggs, hamburger, fried bananas, and many other dishes may be cooked

do. If you don't buy in such large quantities, a suitable can may be obtained from any hotel or restaurant.

To make the stove, completely remove the top of the can, but leave the thick edge *A* around the top. This end of the can will be placed directly over the fire. Then cut opening *B* in the cylindrical side of the tin just below the thick ridge. This rectangular shaped hole must be large enough to serve as a door through which to feed the fire. In a two-quart can this space should measure approximately 2¼ by 3¼ in.

On the opposite side of the tin-can cylinder and at the other end, cut a smaller square opening *C* to serve as a chimney. This time cut only three sides and fold the flap back so that it is parallel to the flat surface of the can. In a two-quart container, the opening should be approximately 1½ in. square. When larger cans are used, increase the dimensions of the two openings proportionately.

The fire must be small enough to fit under the can, therefore twigs and small pieces of wood will best serve the purpose. Prepare a good-sized pile of fuel before you light the fire. As soon as the twigs and wood have started to burn, place the stove over the fire. To make the cooking device draw well, place the opening or door in the direction from which the wind is blowing.

After the can is hot, use green leaves or paper to wipe thoroughly the top or griddle before you cook anything. The tin coating on the iron can has a low melting point and as it liquifies, it forms iron dioxide, which is slightly poisonous. However, if you remove this tin coating when it first melts, there will be no danger.

To eliminate the bother of carrying lard, bacon may be used to grease the griddle. This small griddle has been used for cooking bacon, hamburger, fried potatoes, corn fritters, fried eggs, scrambled eggs, cubed steaks, fried apples, pork chops, fried bananas, fried tomatoes, and wheat cakes.—ELISABETH MINER.

HIGH-LIGHTS IN NEWS OF GUILD CLUBS

Capital Homecraft Club, Washington, D. C. A talk on "Electric Motors for the Home Workshop" was given at a recent meeting by E. W. Parks.

Nampa (Idaho) Home Craft Guild. At a meeting in the studios of broadcasting station KFXD, the following officers were elected: E. L. Goodnight, president; Frank Hurt, vice president; L. A. Wirth, secretary; D. G. Honstead, treasurer; and P. L. McDowell, librarian. . . . Recent activities of the club included the following: An inspection tour of station KFXD; a demonstration on the use of the cabinet scraper and on filing a handsaw by Mr. McDowell; a talk on hobbies of Dr. Philpot, of Boise, Idaho, who was made an honorary member; a talk on natural and artificial flies for fishing by Glen Evans, of Caldwell, Idaho, and a demonstration on tying flies by Mrs. Evans; and a talk on various hobbies for members, especially model steam engines, by Dr. Beck, of Boise, Idaho.

Brunswick (Me.) Homeworkshop Club. A demonstration of the small power saw was given by Benjamin Burbank in the Manual Training Building. . . . An accompanying illustration shows some of the projects recently exhibited by club members in a store window. Ship, coach, and engine models, furniture, carvings, novelties, and even a beautiful handmade violin were included in the exhibit.

Topeka (Kans.) Homeworkshop Club. A club room and workshop have been established in the rear of 324 Van Buren Street through the generosity of William Lewis. In the workshop almost every machine necessary for building any project may be found, including a lathe, mortiser, planer, band saw, shaper, circular saw, clamps, and spray gun. . . . The photography and woodworking classes are meeting regularly. . . . The current issue of the club's monthly "News Bulletin" publishes the following editorial: "About the finest thing your membership in our club is doing for you in respect to craftwork is creating within your mind a consciousness of the fact that you are engaged in a hobby that is worthy of all your powers, physical and mental, and the real joy in life can be found for you in perfecting that which lies within you. It makes you think. Your club contacts help to direct your thinking, and as time goes on the results of your thinking, and perhaps, experimenting, or sudden acquisition of knowledge about the subject of your thoughts enables you to come back to the club and add your knowledge to the common fund. And there's the kernel of the nut. The ideal and the real aim of a member of the Topeka Homeworkshop Club, as we see it: To acquire knowledge and to share it."

Edmundston Hobbyists' Club, Edmundston, N. B., Canada. The officers of this new club, which has twenty members, are Dr. Carmel P. Laporte, president; R. C. Flewelling, vice president; G. P. Griffin, secretary; and William McElroy, treasurer. . . . At the second meeting, Dr. Laporte donated a heraldic club shield depicting in the upper left corner, a hammer and chisel, and at lower right, a bandaged thumb rampant on a field of red, with the club's name across the top. Dr. Laporte also gave a demonstration of tarsia work or intarsiatura as practiced by French experts. In addition, about ten projects were brought to the meeting by various members.

Window exhibition of craftwork by Brunswick (Me.) Homeworkshop Club

Edison Homeworkshop Club, Chicago, Ill. Since the announcement of its spring exhibition and prize contest, the membership has increased considerably. Ten new members were taken in at a single meeting. . . . The judges of the contest have been chosen as follows: Frank Culhane, wood shop instructor, Lane Technical High School; G. A. Freeman, manager of industrial relations, Commonwealth Edison Company; W. D. Golden, wood shop instructor, Lane Technical High School; Robert Johnson, president of the Chicago Association of Window Displaymen; L. Day Perry, principal of the Chase School, Chicago; and L. V. Newkirk, industrial arts director for Chicago public schools. To insure fairness, the kind of tools used in making each project must be listed by the contestant and taken into consideration by the judges. The decision in each case will be based 40 percent upon workmanship, 25 percent upon ingenuity of design and assembly, 25 percent upon the finish, and 10 percent upon serviceableness.

Ozark Homeworkshop Club, Rolla, Mo. At the organization meeting of this new club in the Rolla High School, George T. Capps was elected president and Clarence Gaddy, secretary-treasurer.

Roseburg (Ore.) Homeworkshop Club. A craftwork contest is being planned for this summer. . . . Officers for the ensuing year are W. J. Mess, president; C. B. Calkins, vice president; Dr. R. J. Lockwood, secretary-treasurer; and Harold Printz, J. W. Smith, and D. W. Smith, governors.

Cheyenne (Wyo.) Homeworkshop Club. A junior group has *(Continued on page 99)*

MEMBERSHIP IN GUILD NOW OFFERED FREE

(Continued from page 63)

What the Guild Does. (1) Grants charters to approved home workshop and model making clubs. (2) Supplies annual affiliate cards for the individual members of each club. (3) Gives national leadership and prestige to the entire home workshop club movement. (4) Provides clubs with national publicity and insures national recognition of their work through the medium of monthly articles in this magazine. (5) Issues informative free bulletins on conducting clubs, arranging programs, organizing local exhibitions, obtaining demonstrators and speakers, and other club problems. (6) Distributes a wide variety of free plans, job sheets, book lists, and information about home workshop supplies and equipment. (7) Sponsors other activities according to the wishes and needs of the affiliated clubs as, for example, the great 1935 National Guild Exhibition in Chicago, at which $2,000 in cash prizes, ten cups and trophies, and many silver medals were awarded to Guild clubs and their members. These services are available only to clubs affiliated with the Guild.

What the Guild Requires of Local Clubs. (1) A minimum membership of five and a minimum age limit of sixteen years. (2) Regular meetings, at least ten a year. (3) A pledge that all activities will be undertaken to help members maintain and develop their interest in craftwork and to promote the home workshop hobby. (4) A strictly noncommercial attitude in respect to all club affairs. (5) The prompt report of new members to Guild headquarters.

HIGH-LIGHTS IN NEWS FROM GUILD CLUBS

(Continued from page 98)

been organized, and each junior member receives craftwork instruction in the shop of a senior member. The only requirement for a junior member is to be recommended by his manual training instructor. . . . At a recent meeting L. H. Rees, of Denver, Colo., demonstrated various machines. There were fifty guests, and each signed an application blank. . . . The following committees were appointed for the third annual exhibition and banquet: exhibit, D. R. Kinposts, chairman, W. C. Schlosser, R. Tipton, Robert McMullen; banquet, E. L. Kopp, Jr., chairman, C. W. Huggins, Randall Farris.

Club des Artisans Amateurs, Trois-Rivières, P. Q., Canada. Activities of the club will be continued throughout the summer, and an exhibit is scheduled for July

Chickasaw Homeworkshop Club, Memphis, Tenn. A demonstration of wood carving was presented at a recent meeting. The membership has now reached 37.

Southeast Homeworkshop Club, Huntington Park, Calif. A display of California woods was shown at the organization meeting of this club recently.

Billings (Mont.) Homeworkshop Club. The membership has been divided by the number of months the club meets, and each group has charge of the program for one month. Discussions follow, and a great deal of interest has been created

Woodcraft Homeworkshop Club, Kincaid, Kans. The members are working on projects for the club's annual fair in September.

"Y" Craftsman's Guild, Victoria, B. C. Charles Keeping has been elected president; Mrs. E. Hamilton, vice president; Arthur R. Cann, secretary-treasurer. Two rooms in the local Y. M. C. A. have been assigned permanently as a workshop and lecture room. Negotiations are under way to acquire tools and equipment. A circular saw, carpenter's bench, woodworking tools, bolts, nails, and a large quantity of lumber have already been donated. A. Patterson is constructing a power drill press and is also making patterns for a jig saw for the Guild workshop.

Hyattsville (Md.) Woodworking Club. William H. Koppialky, vice president, recently made photostatic copies of the club's constitution and by-laws and gave them to the members. The club meets on the second and fourth Wednesdays and alternates discussions of problems by members with talks, demonstrations, or special features.

Bison Homeworkshop Guild, Buffalo, N. Y. The club participated in the Buffalo Hobby Show given under the auspices of the Buffalo Council of Social Agencies, displaying ship modeling, wood turning, novelties, hand-tooled leather, hammered copper, applied arts, wood carving, furniture, and a doll house completely furnished. The latter was the work of Mr. and Mrs. Edmund Magarve, who received a special award.

Spanish Lake Homeworkshop Club, St. Louis, Mo. A display of work completed by members since the club's formation was held in the window of a local hardware dealer. The center of attraction was a miniature gasoline engine made by Paul Warnock. Another member exhibited a carving in a piece of rock embodying the National Homeworkshop Guild emblem, and similar emblems are being made to be displayed in members' homes. Officers have been elected as follows: Mr. Warnock, president; Raymond Twillman, secretary; and Jerome Rauth, treasurer. Louis Penningroth has been appointed publicity manager.

Morristown (N. J.) Hobby Crafters. Plans have been completed for the Second Annual Exhibit May 7, 8, and 9. The group was organized in 1934 as the Morristown Homeworkshop Club.

BUILDING A MODEL RAILWAY OIL TANK

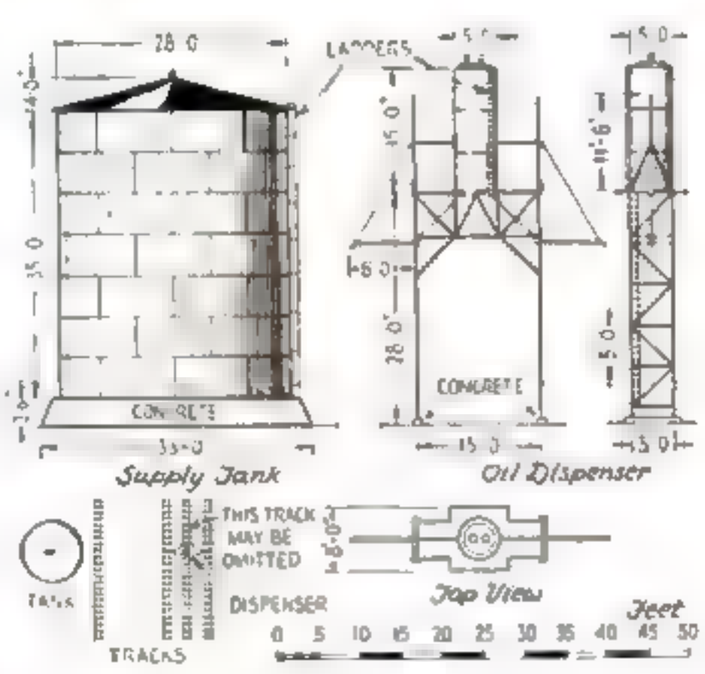
AN OIL tank and dispenser are almost essential if you have oil-burning or Diesel trains in your model railway system. These accessories are easy to build and look very realistic. The pump for filling the tank is so small that it may be omitted.

The supply tank itself may be turned from a solid piece of softwood if a large enough lathe is available, and the tank, roof, and foundation may be one piece. The tank can also be made from a tin can if the correct size is found, or of sheet tin soldered to form a cylinder of the required dimensions; and in either case the roof is a tin cone. The foundation may be plaster of Paris. The ladder is made from wire or cut from a piece of wire screen.

The dispenser's tank, which is comparatively small, is of wood. The steel framework is made of tin bent to form angle irons and soldered at the intersections. The platform is a thin piece of wood. The flood lights can be real or dummies, and the counterweights may also be dummies.

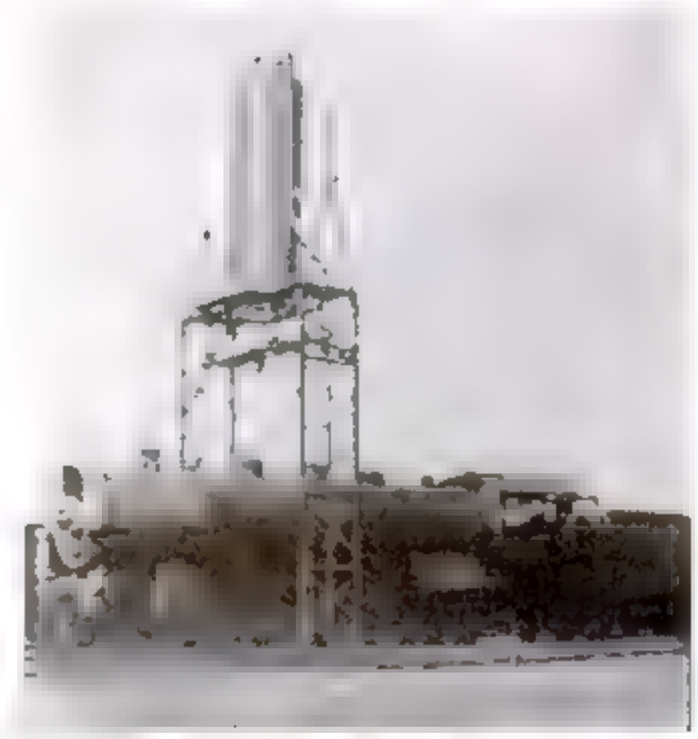
The tank is painted a dull red, and the dispenser black. Many small details may be left off for a neater appearance, but this depends to some extent upon the scale used. The drawings give the full-size dimensions so that the models may be made to suit a railway system of any gauge. If, for example, the system is "O" gauge, make these accessories on the scale of ¼ in. equals 1 ft.

The tank and dispenser should be located in relation to the tracks as shown in the small diagram.—ROBERT FUCHS.



The supply tank and dispenser with a scale in feet, and a small diagram showing layout

Photograph of a typical oil supply tank. A dispenser can be seen in the distance at left



This type of dispenser is common on railroads that have oil-burning or Diesel trains

WOODWORKING VISE

(Continued from page 68)

that the hole cuts the top surface of the cross member for the length of the hole (see the detail drawing of the cross member). The holes are bored in this manner so that the guide sleeves will be clamped tightly between the cross members and the bench top when the assembly is lag screwed in place.

The bench top on the writer's bench is 4 in. thick, but as the reader's will probably be thinner, it will have to be built down to the thickness shown in the drawing. This may be done with short odds and ends, fastened securely with screws and glue, as the vise will exert quite a pull upon this section.

The bench-screw nut is let into the back of the front member and secured with wood screws or bolts.

When the guide-sleeve assembly has been lag screwed to the bench, insert the guides of the front jaw into the sleeves; engage the bench screw and bring the jaw up tight to the bench. The flange on the bench screw may now be secured, and any slight difference in level of jaw and bench top dressed off.

NOTE: All makes of pipe the writer has tried permit the 1-in. size to slide into the 1¼-in. size. It would be well, however, to try this before you have the plumber cut your pipe.

SAND GIVES DECK PAINT A NONSLIP SURFACE

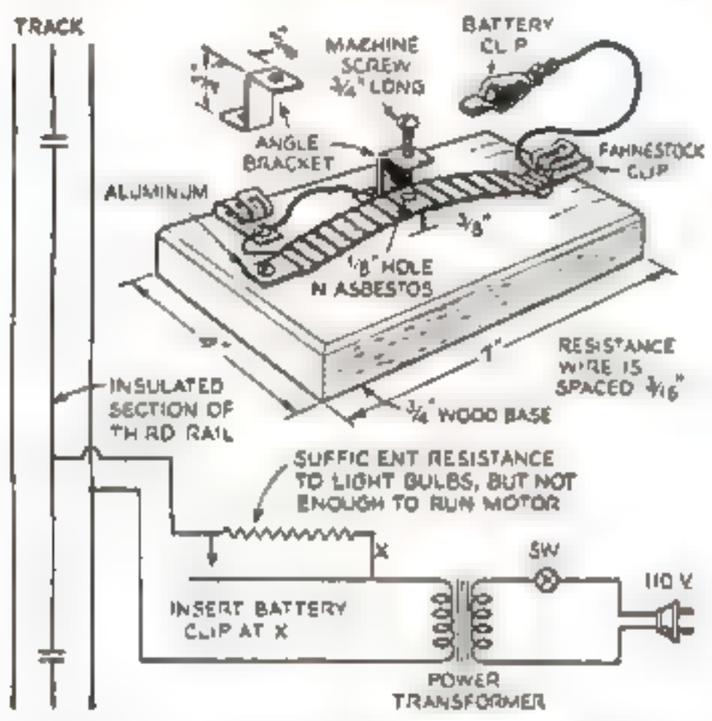
WHILE I was giving the forward deck of my small trunk-cabin cruiser a coat of paint, I had to leave for lunch, and upon my return I found that some small boys had mischievously thrown fine beach sand over a good portion of the freshly painted surface. Several unsuccessful attempts to remove the sand finally made me sit back and think. The result was that I arose and completed what the boys had begun, sprinkling a light, uniform coat of sand over the entire forward deck. The second coat of paint was applied over the sand.

Now, after using the boat for two months in some fairly rough water, I'd like to thank those boys! Like most yachtsmen, I wear rubber-soled shoes on board, and anyone knows how treacherous they are on a spray-wet deck. With the sand undercoating, however, one is sure of a foothold even in the worst rolling and pitching. Your feet grip the deck with a feeling of safety that is hard to describe. The second coat of paint covered the sharp edges of sand so that accidental scraping of the hands or body, when lounging on deck, is not in the least degree unpleasant or injurious.—K. F. KEITH

STATION-STOP CONTROL FOR MODEL TRAINS

IT IS fascinating to watch a model train glide up to a halt at a station. When this is done manually, however, some of the realism is lost. A method for automatically stopping the train at a station for any desired time may be worked out as shown in the accompanying drawings. The device is quite simple, operating on the thermal flasher principle. The materials required are: 7½ ft. of gauge 30 resistance wire; 1 pc. gauge 28 or 30 aluminum, 6 by ½ in.; 1 pc. 1¼ by 5-in. sheet asbestos; 2 Fahnestock clips, ¾ or 1 in.; 3 wood screws, ¾ in.; 1 block wood, ¾ by 4 by 7 in.; 1 S-shaped angle bracket, ¾ in., and 1 small battery clip.

Wrap the asbestos about the aluminum, leaving ½ in. bare at each end. Drill a ⅛-in. hole ⅜ in. from each end of the aluminum strip. Wind the wire around the asbestos, leaving 3 in. of wire for connections, and space the turns 3/16 in. apart. Make sure the wire is not short-circuited to the aluminum.



How the control unit is made, and diagram showing method of connecting it in circuit

Fasten one end of the aluminum to the baseboard with a wood screw, taking care not to "short" the wire to screw or aluminum. Fasten the other end to the baseboard in such a manner as to have the center of the aluminum strip ⅜ in. above the baseboard, after punching a ⅛-in. hole through the asbestos in the exact center of the aluminum strip. A Fahnestock clip is attached to the second screw. The opposite end of the resistance wire is attached to the second Fahnestock clip. From this clip, lead off another 3-in. wire.

Take the brass angle bracket and tap one of the holes for a suitable screw, ¼ in. long Put a wood screw through the other hole and wrap the 3-in. lead wire around it. Fasten the bracket to the baseboard in such a position as to have the tapped hole centered directly over the hole punched through the asbestos.

The battery clip (an alligator-jaw clip is better) is fastened as shown to a 4-in. flexible wire and clipped onto the resistance wire in a position to pass just sufficient current to light the train lights.

When a train passes over the insulated sections of track, it permits a current to flow through the resistor. As the resistor does not pass sufficient current to run the motor, the train comes to a stop, with cars illuminated. If the locomotive is of the remote-control type, the remote-control will not operate at this stop because a current is always passing, and the relay will not be actuated. The resistance wire heats up and warms the aluminum, causing it to expand. Soon it has expanded sufficiently to touch the screw in the bracket, thereby "shorting" the resistor and passing enough current to operate the train, which pulls out of the station. The aluminum then cools and brings the resistor back into the circuit, ready for the next train.—A. LINCOFF.

When Writing Advertisers Mention Popular Science

MODEL OF A TUGBOAT TOWING A BARGE

(Continued from page 75)

is wood graining done by skillful painters.

If you wish to set the model down into a wavy scenic base as shown in the photographs, you should make the hull about ⅛ in. deeper than for a water-line model and paint the lower part copper color. A convenient way to do this is to shape a ⅛-in. thick piece to fit on the bottom of the hull and paint the edges before gluing it on. The base shown is just a piece of plank, gouged out so as to give a slightly undulating or wavy effect and painted a yellowish green to represent the harbor water. The tug and barge are both set into this about ⅛ in., and the bow waves are built up with plastic material.

HOW TO BUILD THE LIGHTER

You must first decide whether you are putting a cargo in the lighter or having her empty, because there is no real water for her to sink into as loaded. If deeply laden, only the toppiece shown will be needed (this would represent about a 15-in. freeboard). If quite empty, then make her about ½ in. deep. The plan shows her as if with a light cargo, 4 ft. being submerged.

Hull. This is made of wood about 3/32 in. thick. Cut a bottom piece, the two sides, and the ends. Glue the sides on the bottom, bevel the lower edges of the end pieces and fit them between the sides, and level their top edges. Cut the top to fit and jig-saw out the center; glue this on the upright pieces. The hull is black, perhaps with a yellow stripe to match the tugboat. The deck is brown.

Coamings. Cut two end coamings as shown of somewhat thinner wood and glue them in the opening. Cut the side coamings to fit and glue in position. These pieces are level with the lower edge of the toppiece and project above.

House. The barge tender's cabin is cut from 7/16-in. wood. It is painted white and has painted windows as on the tugboat, and there is a teak-colored door abaft. The roof is gray. The board with the name of the barge is glued on this and, of course, there is a stovepipe. You may *(Continued on page 103)*

List of Materials

MINIATURE TUGBOAT

No. of Pieces	T.	W.	L.	For
1	7/16	1½	5-3/16	Hull
1	7/16	1	4	Engine room and pilot house
1	3/32	¾	¾	Hatch
1	3/16	¼	7/16	Boat
1	1/8	⅛	¾	Ventilators

NOTE: These parts and those for the lighter tabulated below may be white pine, basswood, balsa or other softwood. All dimensions are given in inches.

1 pc. ¼-in. round dowel, 1¼ in. long for funnel.
1 pc. 1/16-in. round wood 6 in. long for bitts and mast.
5 in. of No. 20 wire for steam pipe, whistle, davits.
12 in. of 6-thread fishline for molding.
Small piece of cardboard.
Black, white, brown, blue, and yellow paint (or other colors as preferred).
Glue or cement.

LIGHTER

No. of Pieces	T.	W.	L.	For
2	3/32	2¼	7-3/16	Hull
2	3/32	3/16	7-3/16	"
2	3/32	¼	2⅛	"
1	1/16	⅝	10	Coamings
1	7/16	7/16	1½	House
1	1/8	⅛	1½	Posts

Paints as for the tugboat.

MODEL OF A TUGBOAT TOWING A BARGE

(Continued from page 102)

List of Materials

SCALE MODEL TUGBOAT

(1/8 in. equals 1 ft.)

No of Pieces	T.	W.	L.	For
3	1/2	3	11¼	Hull
1	5/16	2½	9¼	"
2	1/16	⅜	12½	Bulwarks
4	1/16	⅛	12½	Moldings
2	1/16	3/32	5	Cap rails
1	1/8	3/32	9	Keel
1	1/8	2¼	2½	Stem, stern, rudder
1	7/8	1-13/16	6½	Engine room
1	1/16	2	6¾	Engine room roof
1	7/8	1¼	1½	Pilot house
1	1/16	1½	2	Pilot house roof
1	1/8	1¼	1-7/16	Hatch
1	3/8	9/16	2	Boat
1	1/4	¾	1½	Ventilators
1	1/2	in. round	2½	Funnel
1	1/8	" "	7	Bitts
1	1/16	"	2¼	Mast
2	1/16	3/32	7	Handrail
1	3/32	3/32	8	Stanchions

NOTE: All material may be white pine, but thin members are better if made of a harder wood for strength. Hull may be carved from one piece, if preferred. In this case, use a block 2¼ by 3 by 11¼ in. All dimensions in the list are given in inches.

MISCELLANEOUS

9 in. No. 18 brass wire for steam pipe, whistle, and davits.

Scrap wood, fiber, or metal for bit cross-pieces and ladder

Scrap cardboard for funnel marks. Cord for fender. A four-blade propeller. Glass beads for lanterns. Black, white, teak color, blue, red, and yellow paints. Glue.

COLORING

Hull: Topsides black with yellow stripe, copper sheathed.

Engine room, pilot house, and skylight, teak-wood grained. White deck-edge moldings. Roofs gray.

Inside bulwarks, teak grained.

Handrails, teak. Hawser platform, white battens.

Bitts and funnel black.

Boat davits and ventilators, white

Funnel badge white, L on blue, S on red triangles.

DATA FOR NAME PLATE

HARBOR TUGBOAT
"MAREN LEE"

Owned by Lee and Simmons, New York.
Built at Tottenville, N. Y., 1928.

Gross tons,	140
Net tons,	95
Length,	83′ 1″
Beam,	24′ 0″
Depth,	10′ 8″

also show a radio antenna, some laundry drying, and odds and ends of rope, buckets, and the like lying round.

Bollards. There is a square wooden post on each corner for the towropes. These are set on or through the deck and are black.

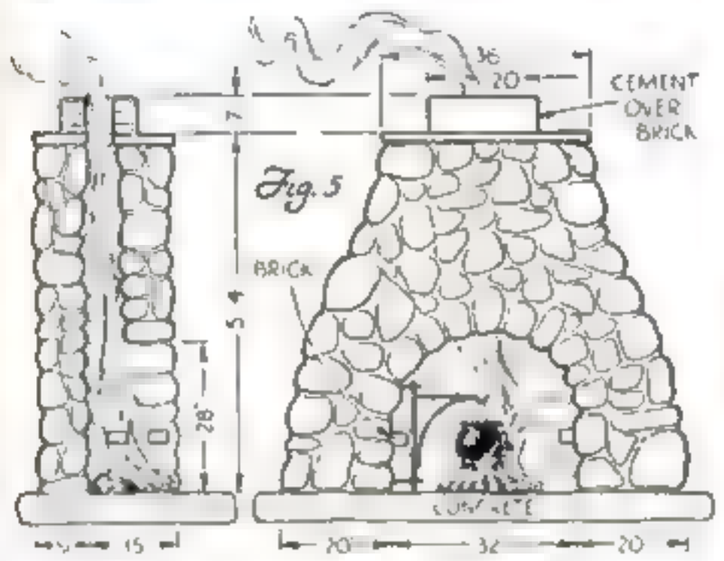
Towrope. If you are having the tug tow the barge, fasten a light cord to the after bitts on the tug and to each of the forward posts

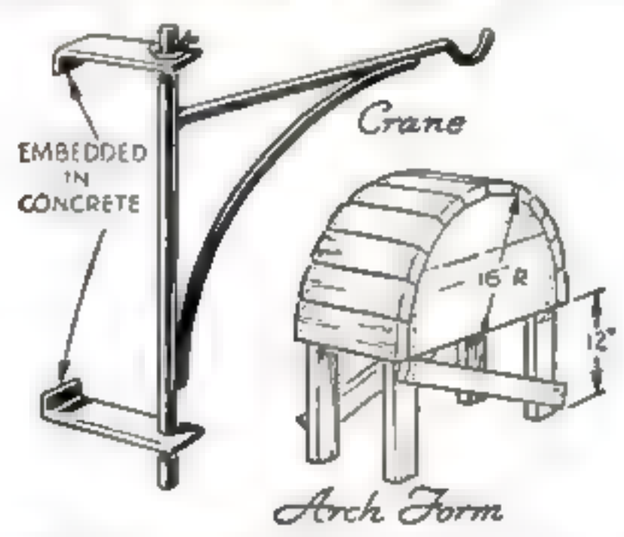
SAFETY PIN SERVES AS COTTER

A CONVENIENT cotter key for experimental work—one that can be inserted or removed with the fingers alone—is found in an ordinary safety pin. When not in use, string the nut on the pin and snap the pin through the hole in the bolt. This keeps the nut and substitute cotter key from getting separated or lost.—PAT MACDONALD.

HOW TO CONSTRUCT AN OUTDOOR FIREPLACE

(Continued from page 58)





Field-stone fireplace of picturesque design in the garden of Harry P. Hammond, Altadena

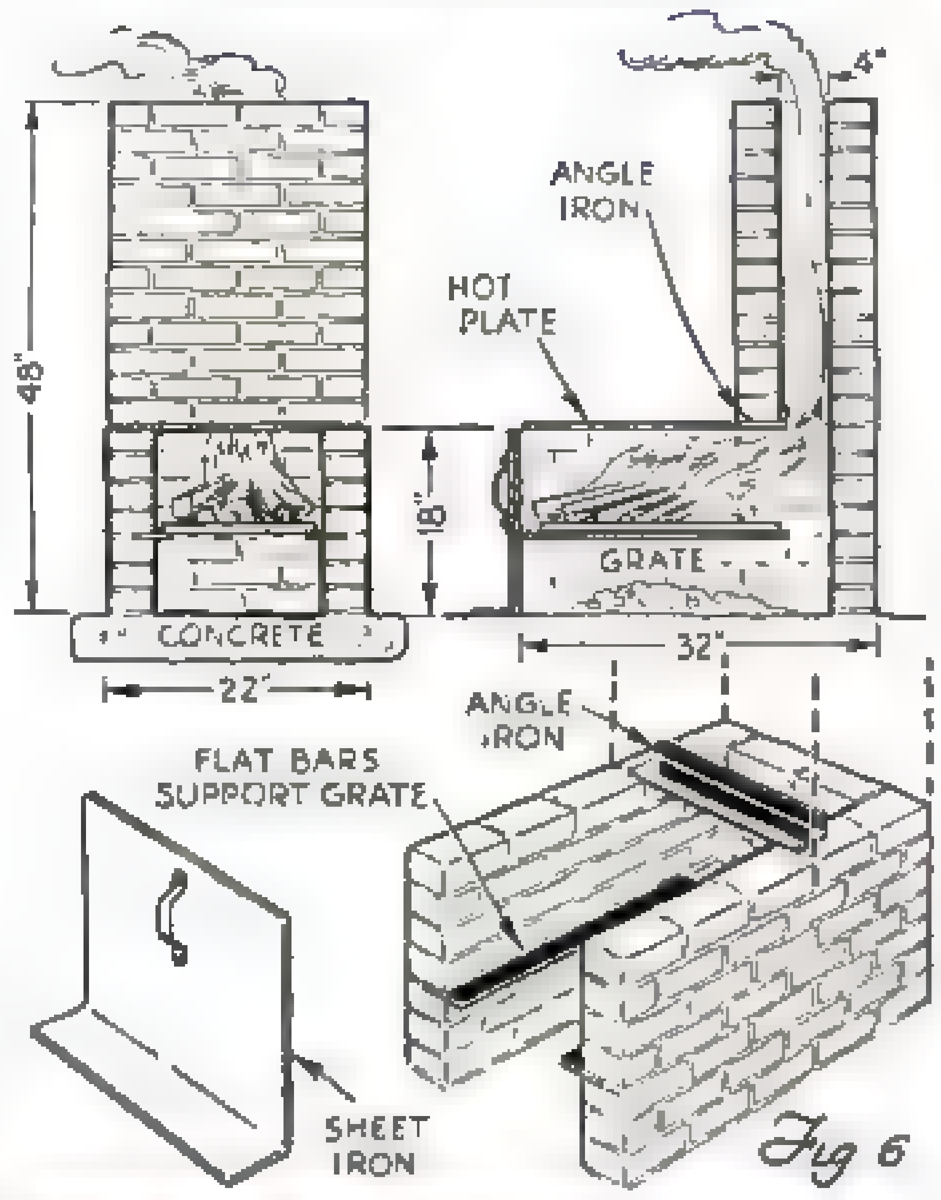
section of the side. One pair of angle irons were riveted to the drum to support the grate bars, and another pair of them were installed above to support the hot plate or grill. The drum itself was set in concrete, and the stonework built around it. Flat stones form the tops of the wings or seats on each side of the fire box.

Where field stones *(Continued on page 105)*

A still simpler fireplace of natural stone on grounds of John Darr, Claremont, Calif.

HOW TO CONSTRUCT AN OUTDOOR FIREPLACE

(Continued from page 104)



Outdoor barbecue oven under veranda roof at Balboa Island, Calif., house of W. H. Fawcett

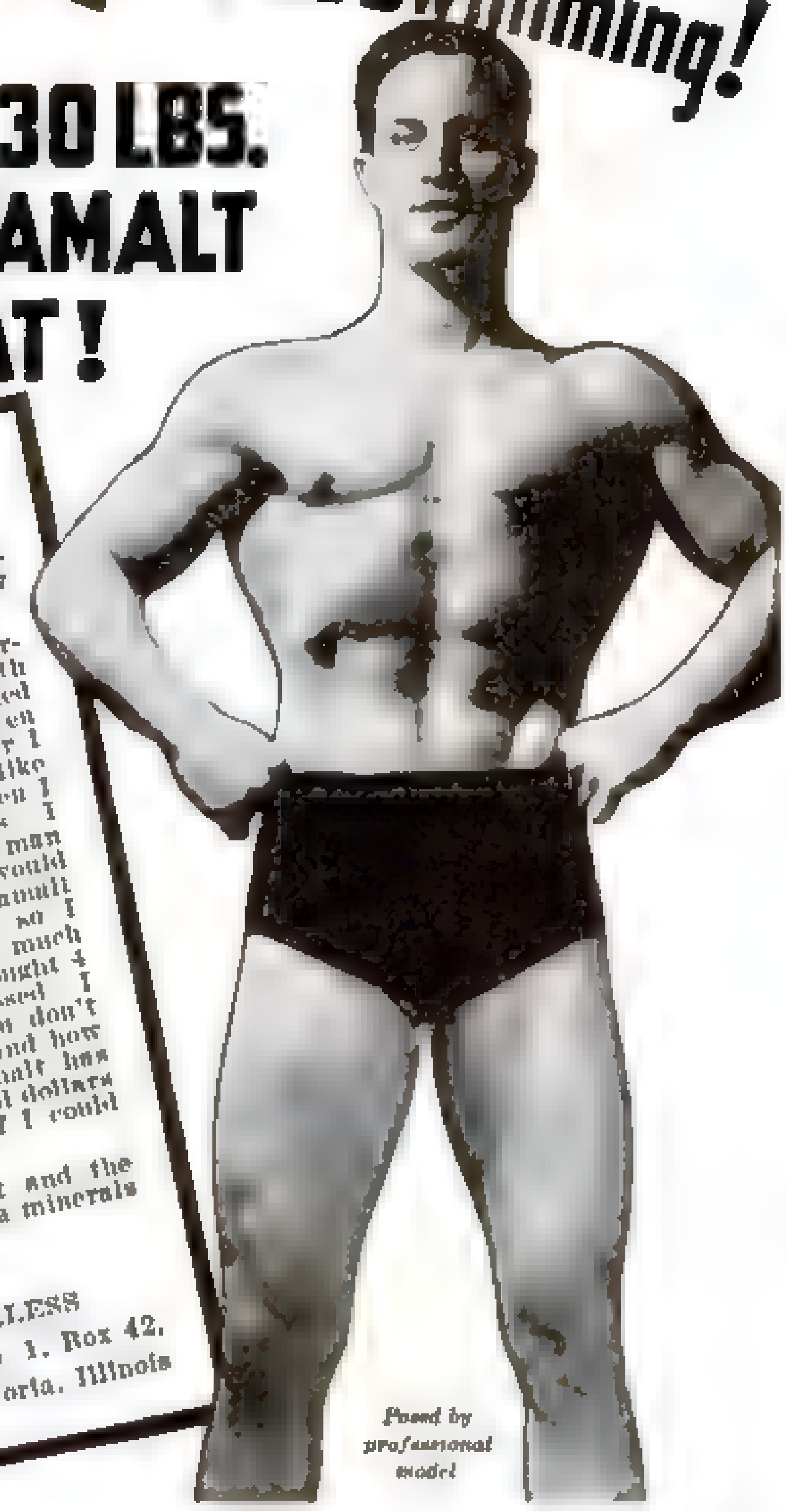
are plentiful, the plan shown in Fig. 4 is inexpensive. Grate bars, an ash-pit door, and a flat plate and broiler are required, together with a heavy flat bar to support the masonry of the chimney above the fire box.

The fireplace of Fig. 5 provides for broiling, boiling, and toasting. The grill or broiler rests upon bricks jutting from the masonry, and the swinging crane supports a pot or kettle. Field stone is used in this particular fireplace, and with an arbor overhead providing shade, it makes a friendly corner of the garden on summer and fall evenings as well as at midday.

About the simplest outdoor fireplace and barbecue it is possible to build is that shown in Fig. 6—merely walls of brick with two sheets of iron for the fire-box door and hot plate respectively. The grate bars rest upon two flat strips of iron laid between the bricks, as indicated. The dimensions can easily be altered to suit individual needs. The photograph immediately below Fig. 6 shows how the same idea may be elaborated to form a decorative outdoor barbecue oven under a veranda roof.

In the photograph at the bottom of the preceding column is illustrated still another simple type of outdoor stove.

Some of the ideas used in these fireplaces can easily be combined, if necessary, to make a design suitable for almost any type of garden or summer camp.



ANSWERS TO SOAP-BOX RACER QUERIES

(Continued from page 71)

slower, it is generally due to the fact that the bearings are overloaded. The only remedy is to install larger bearings or decrease the weight. In some cases, however, this effect is due to underinflated tires.

3. What is the ideal weight? Make the car as heavy as regulations permit, and then make it perform properly by experimenting with everything you can think of until tests show that the top speed has been reached. More you cannot do, and to do less may lose the race for you.

4. Are large wheels better than small wheels? Within certain limits, wheel diameter is less important when using ball bearings than it is when using plain bearings. With the better grade ball bearings and ribbed racing tires, wheel diameter might vary from 10 to 18 in. with little effect. Just the reverse applies to plain bearings, because in these bearings friction is high even under normal operating conditions. To illustrate, suppose we have two cars which are alike in every respect except wheel diameter, and they are driven over the same course in exactly the same manner. In this case the large wheels will have greater mechanical leverage over bearing friction, and consequently will be faster. With plain bearings this effect will be definitely noticeable, while with ball bearings in good condition it will be negligible.

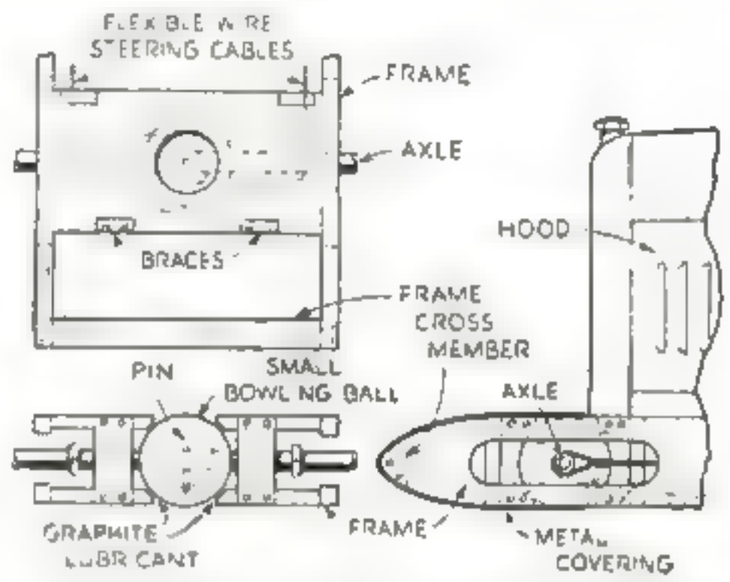
In drawing a conclusion to this problem, the decision favors the use of wheels as large as regulations permit, although the financial problem of manufacturing such wheels at a low cost may make their use prohibitive By using the tentative plan suggested later and making the wheels at home, this limitation is lifted and you have the additional advantage of being able to choose whatever tire you wish. Bear in mind also the fact that large wheels and small cross-section tires reduce road contact area greatly with the result that tread design is less important. This makes it practical to use bicycle tires (not bicycle wheels).

5. What type of wheel should be used? This is both a financial and a mechanical problem. One solution is to make the wheels at home. Good workmanship and considerable labor will be required, but you will be assured that your car is equipped with "rolling parts" that will give maximum performance.

The preferred type of wheel must be rigid laterally in order to resist side vibration and to withstand the tremendous side loads caused by skidding. To do this the wheel bearings should be spaced far apart. The disk wheel, if properly designed, meets these requirements better than other types and is about the only wheel that can be simplified sufficiently for construction at home. A suggested plan for making such wheels is shown. If no woodworking machinery is available, you should be able to do most of the work with ordinary hand tools and have the final finishing done in a local shop for a small price.

6. Do some types of wheels have disadvantages? Yes. The bicycle wheel, for instance, is designed only for carrying its load in a plane parallel to the plane of the wheel and will not withstand very much side thrust. When four such wheels are attached to the same rigid framework, the large loads are too great. In case of a skid such wheels might collapse with disastrous results, and in any event they are not sufficiently rigid to resist vibrational tendencies.

7. What type of tire is best for soap-box racing? Pneumatic, because this type of tire is the most resilient or springy and will absorb ordinary road shock such as bumps instead of transmitting it to the wheel bearings where it would increase friction. The problem of tread design has already been solved by the builders of tires for racing purposes on regular automobiles. Two distinct types of tire treads are in use, one designed for resistance to skidding, as on the dirt track or in cross-country racing, and the other for beach racing or on the speedway. The latter is the tread design to be used, if possible. It may be recognized by the fact that no crosswise pattern is present, the design consisting simply of molded grooves which run all the way around the tire. There may be from two to five of these grooves, depending upon tire size. Such a tread is known to have the lowest possible resistance to forward motion.



Small bowling ball used as axle mounting and universal swivel. The opening for the axle should be restricted in length so that the wheels cannot rub on the frame when turning

8. Was the 1935 winning car in the All American Soap-Box Derby finals equipped with "ribbed" racing tires? Yes. Maurice E. Bale, Jr., of Anderson, Ind., the driver, said that this tread design had been selected because it has low rolling resistance. The tires on his car had two grooves in the tread. These were spaced about ¼ in. apart, and the rib between these grooves formed the main supporting member under normal conditions. With the car loaded, this rib made contact with the road over a width of 7/32 in. The two outside ribs were sharp edged where they touched the road, and they tapered to their respective side walls. When the load momentarily increased because of bumps, these ribs increased their area of road contact accordingly. Added to these features was the shock absorbing qualities of a single-ply tire carcass. Altogether these tires were probably the most resilient and best designed tires on the race course last year.

9. Is tire inflation pressure important? Extremely. The slightest deviation from the optimum or best pressure may be a direct cause of losing the race. Remember that gravity is your only source of power for forward motion down the hill, and this force may be reduced tremendously by the slightest increase of rolling resistance. One of the most effective methods of increasing this resistance is to underinflate the tires. A striking example of the change of tire rolling resistance relative to pressure is shown in an accompanying table. If you want a personal demonstration, then let the tires down part way on a bicycle and see how hard it is to pedal up a small grade.

This does not indicate that the hardest tire is advisable by any means. On the chart you will notice that rolling resistance diminishes rapidly as the pressure increases until finally a point is reached where a unit increase of pressure fails to decrease rolling resistance (Continued on page 107)

ANSWERS TO SOAP-BOX RACER QUESTIONS

(Continued from page 106)

greatly. Do not increase the pressure above this point.

10. Is the best pressure for all tires the same? No. We have seen how critical tire pressure is in its relation to speed. Due to the difference in tires and weight from car to car, the best pressure for the tires on one car may not be best for those on another. Likewise, the best pressure for the front tires on any one car may not be the best pressure for the rear tires. The only way to find what pressure to use is by means of carefully made tests on the race course. In these tests the best plan is to make at least five runs over the course, averaging the results, before making changes.

11. What kind of wheel bearings are best? The hardened and ground type of ball bearing has the least frictional resistance of any bearing suitable for use here. The bearings must be in good condition and must be kept clean to show their advantage. Inferior grades of unhardened ball bearings should not be used because they invariably score in service and thus increase rolling resistance. New ball bearings of the better grade generally cost more than the average driver cares to invest. However, this should present no problem since most city junk yards yield any number of such bearings which are in fairly good condition. When mounting the wheel bearings, regardless of type, see that some effective means is provided for keeping dirt and grit out of the bearing compartment.

12. What lubricant should be used in the wheel bearings? Our lubrication problem is quite different from that of a conventional automobile. Our greatest problem is to prevent the slighest scuffing or scoring due to dirt or high overloads. To prevent this a lead-base automotive transmission lubricant thinned with light cylinder oil should be used. This lubricant is mainly for use in bearings where steel runs on steel or cast iron runs on cast iron.

Where bronze bushings and steel shafts are used, the lubricant should be one that stays on the running surfaces at all times. Some engineers have advised thin cylinder oils, but my own observations have shown me that this lubricant alone is not sufficient to resist the cutting action often started by high impact loads such as those as caused by bumps. My advice would be to use a graphite-oil mixture, making sure that the graphite is of a superior grade, free from clay and other harmful abrasive fillers. Ordinary commercial graphite should not be used.

13. How should wheel bearings be mounted? Last year I saw a few cars which I am sure had been defeated partly because of the method of holding wheel bearings in place with washers so large that they rubbed against running parts of the wheel. Wheels should be held on their axles by means of a small metal collar welded or pinned to the shaft on the inside and a lock nut on the outside. Make sure that none of these parts rub against moving parts of the wheel.

14. How should the wheels be aligned? We are dealing mainly with straightaway race courses and must sacrifice desirable turning characteristics in order to gain all speed possible. The wheels must therefore be aligned so that they are at right angles to the surface upon which they run, and the plane of the wheel must be parallel to its path of travel.

15. What type of axle is best? Since the wheels are to be aligned parallel and straight, nothing could be simpler or more efficient for use here than a straight tubular axle.

16. Is streamlining worth while? That's a problem which hasn't been settled either way. Many automotive engineers say it isn't important, but there *(Continued on page 108)*

ANSWERS TO SOAP-BOX RACER QUESTIONS

(Continued from page 107)

are more points in favor of its use than against it.

In aeronautical physics we find that a surface 1 ft. on a side, when traveling broadside to the wind, would have resistance to forward motion to the extent of 2.7 lb. at 30 m.p.h. Where a race is decided in a margin of inches, it is important to reduce all resistance as much as possible. Soap-box cars, small as they are, must certainly have sufficient wind resistance to equal 2.7 lb. at this speed, or more.

There is a particular condition which I think favors streamlining. Suppose that on the day of the final race a 15-mile breeze hits you in the the face as you roll down the race course. As you near the goal line, your speed reaches nearly 40 m.p.h. Add the speed of the car to that of the headwind and you have an airspeed of around 55 m.p.h. Does streamlining count then? It must, and especially so on the last hundred feet of the race course

Some engineers reply that you can't streamline for side winds anyway. That may be true, but the final national race is on the Akron course, and that course seldom has side winds. My advice is that, if you must use a body of any kind on the car, then be sure to make it streamlined. Otherwise use no body at all.

17. Will springs make the car faster? There are several points favorable to the use of spring action, regardless of how it is obtained. One argument is the fact that forward speed might be lost by allowing the tires to absorb all road shock instead of taking some of it up in springs or rubber shock absorbers. In this connection the use of flexible wheel mountings will reduce the unsprung weight. Instead of the car's entire weight being raised by a bump, only the lighter undercarriage is raised, thus less forward energy is used in deflecting the tires, and the car rides easier. Spring action may be obtained several ways such as by using a straight tubular axle mounted on rubber supports, by using conventional leaf springs, or by using a flexible frame.

18. Will individually sprung wheels add to the car's speed? Not necessarily, although it is important to have one of the axles swiveled so as to prevent overloading any one or any pair of tires when passing over bumps. Personally, I shoudn't risk the effects of improper wheel alignment which may be present with individually sprung wheels.

19. Is the driver's method of driving important? It is. A tremendous braking action develops when an automobile is making a turn. For this reason the driver should train himself to drive the straightest course possible, and he should also be trained to stop quickly any swaying motion which starts.

20. What are peak speeds and how can a car be tested for the effects of improvements? There is a maximum top speed that can be attained on every particular down grade beyond which you cannot go regardless of improvements made to the car. By having some one drift down the grade with a motorcycle, you can determine this speed with reasonable accuracy, provided the motorcycle is in good condition and the tires properly inflated. Invariably, if driven down the grade properly, a motorcycle will be slightly faster than the fastest soap-box racer.

To win any important soap-box race, you must be relentless in your search for improvements. Remember that winning the locals means only that you have gained the privilege of being pitted against the country's best cars and drivers. And first prize in the national finals is far greater than many famous dirt-track drivers ever raced for.

SAILING-CANOE DECK

(Continued from page 67)

resting against it for some 3 in. in a close bevel joint. Plywood of ¼-in. thickness is the best material, but ¾-in. white pine will serve very well. Nail the frames to the stringer and secure to the wales by means of tabs nailed to the underside of the wales and to the frames. Then saw away the center section of each frame, being careful to leave enough material along the after side to permit cutting the curve.

BEFORE this curve is laid out, it will be necessary to determine the width of deck to be installed along the waist—3 or 4 in. should be enough. Cut a number of spacing blocks of ⅞-in. white pine to the required dimension and secure them to the wale with tabs at equal intervals. The two blocks nearest the stern, probably just about amidships, will be rounded and rabbeted at the forward corner to take the subcoaming, which is a piece of 1½ by 3/16-in. spruce of sufficient length to reach from the rabbet to the peak of the cockpit. Using the subcoaming piece as a rule and bending it along the blocks and against the frame, lay out the curve for the coaming on one side and cut it with a coping or keyhole saw. Work it fair and make a pattern of cardboard from which to mark the opposite side. Trim away the upper edges of both curves to give the coaming its flare.

Bend in the subcoaming and miter at the peak to a snug fit against the stringer. Nail the strips sparingly along the diamond frames and to the blocks at the waist. Saw away the projecting end of the stringer, making a V-cut in plane with the inner faces of the subcoaming. These subcoamings should be allowed to project above the frames and blocks about ¼ in. so that the decking may cover smoothly.

Forward, between peak and mast step, locate two or three equidistant crosswise supports. These do not have to be curved on top; in fact, it is better to cut them straight like house rafters so that there will be no chance of their touching the deck covering anywhere. They should be secured to the wales with blocks and tabs and notched to fit and support the stringer, but sufficiently below the deck line to prevent showing as ridges

The entrance to the mast step will be below the new deck line. Cut several pieces of white pine and tack them one upon the other until they are almost the desired height. Saw a disk out of each just the size of the mast at that point; then set the laminations in place, screwing the first to the top of the old step and gluing and nailing the rest, one upon the other. The last piece must be cut to allow the stringer to pass through, beveled away to conform to the deck line, and nailed to the stringer as well as to the piece next below. Cut away the stringer where it crosses the step.

WITH plane and sandpaper, round the deck stringer decidedly and the edges of the subcoaming slightly.

Common ten-cent store oilcloth, especially if treated on the underside with airplane dope after being put in place, makes an excellent covering for this use. However, airplane cloth or good unbleached muslin can be used with equal success. Either material can be painted to match the canoe, though oilcloth can usually be obtained in a matching or contrasting color, and thus saves the trouble of applying several coats of dope and enamel

A piece of oilcloth long enough to reach the full length of the proposed deck is necessary Should it lack a trifle in width at the point of greatest beam, it can be made to serve by splitting that end a little before tacking.

Remove the screws holding the end of the bang iron and, if the canoe is fitted with outside wales, those holding the wales along the part to be decked. Slip the end of the cloth under the bang (Continued on page 110)

Midget Motors Go Mass Production

TAKE a trip with our cameraman through the factory where they assemble these tiny gasoline engines. See them built. Watch them, later, as they knife through the air overhead in test flights.

So realistically do the planes perform that when one crashed a while ago, three police cars and an ambulance rushed to the scene thinking the ship life-size! Model flying—with real power plants—has given amazing impetus to this fascinating hobby; today the demand for midget motors is of such proportions that the manufacturers have had to go on a mass production basis.

In its latest edition, "POPULAR SCIENCE"—Paramount Pictures' sound and color series of "shorts"—shows you all this. It shows you, too, new methods of studying earthquake strains and stresses; a new hot-cake grill that will turn out 500 "wheats" in less time than you could tell about it; the metamorphosis of the caterpillar into a butterfly; startling new explorations of the X-Ray into the human body. Much as you may have enjoyed previous installments of "POPULAR SCIENCE" in the movies, here's one that will thrill you even more.

SAILING-CANOE DECK

(Continued from page 109)

iron and replace the screws. With a light line, tie the ends of the outwales down and out of the way, passing a few turns of the line beneath the keel. Stretch the cloth diagonally aft and across the breasthook and secure it with fine copper tacks, driving them fairly close together in the space to be covered by the outwale. Even a sharply dished deck stringer may be covered without a wrinkle if you are willing to work slowly and use a little patience

ON REACHING the wale opposite the cockpit, stretch the cover right across and, when made fast at both wales, press the material down inside the subcoaming and tack there, cutting away the waste only after the deck is tight and smooth. Oilcloth can be stretched too tight, resulting in tearing or wrinkling when the canoe twists under sail pressure, so do not strive to obtain a drumhead fit.

Tack the decking around the mast step, cut out the hole for the mast, and glue on a grommet of oilcloth, using quick-setting cellulose cement. Place similar reënforcings at points through which braces, stays, or bolts must pass. Where the halyards pass through the deck, it is well to pass light line through the hole and lead it aft so it will be unnecessary to crawl up beneath the deck to reeve the lines when rigging. Screw the outwales back in position. Some canoes do not have outwales; in this case thin strips may be made and tacked or screwed over the cloth.

Any inexpensive, easily bent plywood will do for the coaming. First make a pattern 4 or 5 in. in width at the forward end, tapering to from 1¼ to 2½ in. where it fits along the side deck and across the wale. At the peak it will be from 2 to 2½ in. above deck, and the height will decrease gradually as the coaming runs aft, being from ¾ to 1 in. along the waist. In cutting the forward end of the pattern, the first cut can be nothing but an approximation. Fit and try until you have a fairly good fit.

Saw the coamings out, bend in place, and hold with loosely set up clamps. The joint probably will not be as close as desired, so tap each coaming forward until they are as close together as they will go; then, with a back saw, cut down between the two, removing a part of each piece. Alternate tapping and sawing will eventually produce a close joint, but, if you become impatient, a triangular stem block can be nailed into the peak and wood plastic used to fill the remaining openings. Fasten with evenly spaced screws.

THE after ends must now be bent outward round the curved blocks where the deck ends. In order that water thrown on the side decks may be led overboard, it is quite important that the coamings above deck run across the wales to the very outside of the outer wale. It will be necessary to soften the plywood. This is not difficult as the piece is small and, if of moderately good grade of plywood, it will not come apart. Wrap the part to be bent in a piece of burlap and, placing a large dish pan underneath, pour a kettle of boiling water over it slowly. Hold it in place securely with screws driven into the end block.

After the coaming has dried, it should be sanded smooth, stained to match the rest of the trim, and varnished with good spar varnish. Other parts of the job, excepting the strip along the wale if one is used, need not be varnished unless the job is more permanent than temporary.

If a leeboard thwart crosses the deck, the coamings may have to be notched to fit it and small holes may have to be let through the deck, but these do no harm.

WONDERS OF SEA SHELLS SHOWN BY MICROSCOPE

(Continued from page 45)

of objects that cannot be lighted or otherwise made suitable for direct observation. Human hairs, for example, prove difficult subjects to the microscopist who attempts to see their surface markings distinctly. These markings, incidentally, are somewhat like those on mother-of-pearl, but do not cause pearly iridescence. With the aid of collodion, inspection of hair surfaces, as carried out in criminological laboratories, is easy

The hairs are first washed in a solvent that removes grease, such as xylol. Then they are laid on a glass plate and their ends fastened down with adhesive tape or paper. A little boxlike, shallow well is built around the hairs with the tape. Into this depression is poured a sufficient quantity of collodion to fill it. When the collodion has become firm, it is peeled in a sheet from the glass; and the hairs are then pulled away from it, leaving perfect impressions of their surface markings. The collodion cast is mounted on a slide and inspected by transmitted light.

YOU can make similar casts of various other things. A cast of a portion of the surface of a coin will reveal the tool marks of the die maker, or the pits formed by oxidation of the metal. The surface of metal that has been highly polished and then etched with nitric acid or some other reagent, in the manner usually employed for preparing metal for microscopical examination with a vertical illuminator, will leave an imprint of the crystalline structure of the metal on a collodion film.

Usually, the films are seen best when examined dry. That is, you simply place them on a clean glass slide, marked surface uppermost, and lay over them a clean cover glass. The glass can be fastened down at the edges with gummed paper, shellac, or other material, for permanent preparation. In examining the films, you will be surprised at the variety of effects that can be produced by changing the mirror angle, masking off one side of the light beam from the mirror, and similar stunts. With a little experimenting, it usually is possible to produce the effect of relief, as seen in some of the accompanying photomicrographs of film casts.

But, so far, you haven't found out a great deal about the actual structure of the shell under consideration. One path of further exploration leads to the making of thin sections of shell. That is, you put the shell through a process that produces a very thin slice, either at right angles to the surface or approximately parallel to it. The parallel section is easiest to make. Break off a piece of shell about as big in area as the cross section of a lead pencil. This piece will be slightly saucer-shaped in most cases. Obtain a two-surfaced razor hone, or two hones, one fine and the other coarse. Wet the coarse hone, lay the piece of shell on it with the dished-in side uppermost, and with your finger rub the piece back and forth on the hone until it is ground flat. Then transfer it to the fine hone, and bring to as high a polish as possible. The finer the hone, the more perfect this polishing will be.

PLACE a drop of Canada balsam in the center of a clean microscope slide, and warm it gently over a gas flame or a little electric stove like that described in a recent article (P.S.M., Feb. '36, p. 44). Heat the balsam until most of the solvent has evaporated. Do not overdo it. While the balsam is warm and sticky, lay the piece of shell, previously washed and dried to remove dirt, on it, polished side down. Press firmly against the glass, and set the slide aside to cool.

When the balsam has hardened, grind the other side of the shell down, and polish in the same manner as *(Continued on page 112)*

WONDERS OF SEA SHELLS SHOWN BY MICROSCOPE

(Continued from page 111)

for the first surface. Because it is possible to overdo the grinding, examine the specimen frequently through the microscope as the section becomes thin. When the polishing is finished, wash the specimen well, put a drop of water over it, lay a clean cover glass on, and you are ready to study the interior structure of the shell.

You see the same mosaic-pavement formation, except that the blocks are now all of the same level, and perfectly smooth. Move the slide sideways, and you suddenly find a boundary where the block pavement ends to give way to an entirely different formation. This new section seems to be made up of innumerable wavy lines, which run in every direction, but seem to have a general systematic arrangement in one direction. They look very much like the grain of yellow pine or a similar wood. This is the mother-of-pearl material in thin section.

IF YOU make a section perpendicular to the surface of the shell in the area that shows a mosaic effect in a section parallel to the surface, you will find that there are a great many more or less parallel lines, looking somewhat like a handful of matches viewed from the side.

And thus you have discovered the nature of the mosaic layer. It is composed of numerous blocks of some hard material, each block being, in most cases, hexagonal in shape. When blocks are in position, they extend from outer to inner surface of the layer, their length determining the layer thickness. Thus when you polished the first piece of shell to make a thin section, you were cutting a great many blocks crosswise. The mother-of-pearl, in cross section, shows a wavy, laminated formation.

The hexagonal blocks are crystals of lime, or calcium carbonate, a material common in bones, teeth, and all mollusk shells. Lime is a very convenient material for all animal forms to employ. It can be used in so many shapes. One of the most beautiful pure-lime formations is seen by looking at a little block of cuttlefish "bone" with a microscope.

But to get back to the shell in question. If the blocks are of lime, why wouldn't the shell disappear if immersed in weak hydrochloric or nitric acid? Why not try it? Make a solution of about one part concentrated hydrochloric (or nitric or sulphuric) acid in ten parts water. Undiluted vinegar can be used, if no other acid is available. Drop into the acid solution a piece of the shell. Also, while you are at it, immerse the slide bearing the thin section of shell—the one made parallel to the shell surface—removing, of course, the cover glass. Set the acid containing the specimens aside over night.

IN THE morning, you will find that the shell has not disappeared, but that, for the most part, it looks very much as it did before, although it now is limp and flabby. The microscope reveals that there are the same mosaic blocks, and the same wavy lines on the inner surface. With a pair of dissecting needles, tear apart some of the mother-of-pearl material. This is easy, for the shell now consists only of animal tissue, without the strength-giving lime.

The mother-of-pearl resolves itself into layers of thin membranes, which the microscope shows to be folded in innumerable fine creases. These membranes, when properly illuminated, exhibit beautiful coloring. Stretch one of the membranes out, so that the creases disappear, and the iridescent colors likewise vanish. Mother-of-pearl, therefore, is a formation of properly folded membranes arranged in layers whose edges are visible on the surface of the piece; and these membranes normally are reënforced *(Continued on page 113)*

WONDERS OF SEA SHELLS SHOWN BY MICROSCOPE

(Continued from page 112)

with supporting infiltrations of lime.

Examine the slide bearing the shell section, and you find that the mosaic pavement has become a network of honeycomb cells. Tilt the substage mirror first one way then the other, so that the light beam strikes the specimen at different angles, and you may be able to catch a third-dimension glimpse of the sides of these cells, as shown in one of the accompanying photomicrographs. The piece of decalcified shell that was not ground reveals, when examined, that each of the cells that used to house a limestone prism is capped on each end with the same animal membrane.

THUS a typical shell of a mollusk such as the mussel and oyster is made up of three general layers. Inside is the mother-of-pearl layer of laminated, folded membranes and limestone. Next is the mosaic layer of column-like limestone crystals. Then, outside, is a very thin layer of tough membrane, which extends down between the crystals; and which is believed to protect the limestone from the action of the acids encountered in the water in which the animal bearing the shell lives. In many shells, the mother-of-pearl lining stops short of the shell edge.

You will not find this exact formation in all shells. In most of them you will find variations of one sort or another. The best shells for your first researches are, as already mentioned, the mussel, oyster, and similar bivalves.

As far back as 1870 or thereabouts, a microscopist named George Rainey described a method of making "artificial shell" resembling in many ways the prismatic layers of certain natural shells. This is Rainey's method:

Make separate solutions of a soluble compound of lime (calcium carbonate or ordinary slaked lime), and potassium or sodium carbonate. Ordinary washing soda is sodium carbonate. Mix with each solution some viscid animal substance such as albumen (the white of an egg). The quantity of the animal substance in each solution should be such that, when the two solutions are mixed, the density of the resulting solution will be the same as that of the carbonate of lime solution alone. Set the resulting mixed solution where it will remain undisturbed for about three weeks. The crystalline layer, composed of limestone crystals imbedded in the animal material, very much like that in natural shells, forms over the sides and bottom of the vessel. Rainey found that no further crystalline growth takes place after about six weeks.

BALLISTICS CAMERA IS WORK OF T. N. LEWIS

A "COMPARISON CAMERA" that matches bullets and establishes crime clews, was erroneously described in a recent issue as the invention of Prof. J. H. Mathews of the University of Wisconsin. (P. S. M., Mar., '36, p. 24). Full credit for original development of the apparatus, which he reports he has modified and supplemented with new features, is given by Prof. Mathews to Thomas N. Lewis, former head of the Forensic Ballistics Bureau of the St. Louis, Mo., police department, and POPULAR SCIENCE MONTHLY is glad to make this correction in the interest of accuracy.

ANNUAL TIN-FOIL OUTPUT WOULD COAT HUGE AREA

ASSUMING half its surface to be occupied by windows, a structure shaped like the Empire State Building in New York but towering sixteen miles high, could be completely coated with the tin foil produced in the world's factories last year.

Secrets of Success

STORIES THAT WILL HELP YOU GET AHEAD

MORE $5 PRIZE WINNERS

Three prize winning letters in POPULAR SCIENCE MONTHLY'S new Secrets of Success contest—"*What Home Study Has Meant to Me*"—are printed below. Read these stories carefully because your own career may be just as interesting and inspiring to other readers. If you think so, put it down on paper and send it in. We will pay $5 for every letter we publish.

CONTEST RULES

Only letters from bonafide home study school students will be considered and these must contain the name of the school and the name of the company, or companies, for whom you have worked since graduation. (Names, however, will be deleted from the letters when published.) We also want to know the kind of course you took and the type of position you have held. Your own identity will be kept anonymous, if desired.

We are interested in facts, not literary ability, but please write clearly, completely, and keep your letter within 750 words. We are not looking for "get-rich-quick" stories or freak adventures, and authors must be prepared to substantiate the truth of the statements. Manuscripts submitted and printed become the property of this magazine, and we are not responsible for the return of rejected stories unless sufficient postage is provided for this purpose. Address your contribution to Success Story Department, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

PARALYSIS COULDN'T HOLD HIM BACK

Did you, when a boy of ten or twelve, have your mind definitely made up as to the occupation you intended to pursue? I did. But sometimes fate has a way of changing things so quickly that it leaves you gasping.

A serious infantile paralysis epidemic broke out in our section of the country while I was in elementary school and I was one of its victims. After recovering somewhat from being totally paralyzed I continued with my schooling . . . at home; two years of elementary and four years of high school. As I was (and am) still unable to walk, I began to think pretty seriously of what I intended to do for a living.

Fortunately, I was enrolled in the State Rehabilitation Bureau and with its help and that of friends and relatives, I decided that there was just one course of training for me—watch-making. I received correspondence training from the Rehabilitation Bureau in clock and watch repairing under the direction of a local jeweler of excellent reputation. The Bureau also loaned me a complete line of tools until I had learned the trade and was able to partially stock my own.

Although the paralysis had robbed me of the use of my legs, my hands were as

Secrets of Success

good as ever and I was surprised at my progress after several lessons. I also found that one big thing in this business is patience and luckily I had pretty well acquired that by the time I graduated from high school. I had been greatly interested in making toys and novelties all my life, and this love of craftsmanship stood me in good stead.

I am a farm boy living with my parents and I draw all my trade from rural people. What pleases me is that these people will gladly patronize one of their own number if they feel they are getting value received. There is a good opening for trained watchmakers, especially in rural districts, as many of them are not particularly skillful

During the two and a half years that I have been at the bench, I have repaired hundreds of watches and clocks. Considering that the financial status of farmers has not been so good of recent years, I feel fortunate that I am doing as well as I am. Certainly it has been interesting work, particularly when I have some old heirloom clock or watch to repair, for they are quite different from modern timepieces.

Some people may think that in selecting my vocation I took the only one open to me. While this is largely true, I will say that I get a tremendous kick out of it. Who wouldn't?—*H.H., Greenville, Ohio.*

GROCERY CLERK BECOMES CHEMIST

Ever since I was a boy of ten, I have been intensely interested in chemistry. All my nickels and dimes went for small quantities of Blue Vitriol and Muriatic Acid (the only names by which I knew the compounds) and other simple chemicals. Constantly I dreamed of the day when I would attend college and study my hobby.

But as I neared my last year in high school I realized that college for me would never be more than just a dream. Soon after graduation I began working in a small suburban grocery at a smaller salary than you'd think even this store would pay, and practically gave up any serious thought of becoming a chemist.

One evening (feeling that I was just wasting a stamp) I sent for the catalog of a large correspondence school. The abundance of information it contained so convinced me that it was what I wanted that I immediately enrolled for the course in analytical and industrial chemistry.

As soon as the first lessons came, I began my studies and found them a regular mine of information. They were so clearly presented that it was a pleasure to work on them. I progressed quickly and the further into the course I went, the more interested I became. The small payments necessary for the course left me still sufficient money to buy additional chemicals and equipment.

I experimented in my laboratory as directed by the course and analyzed the many samples of chemicals, alloys and ores sent me by the school. In this way my studies were made very practical and besides the theoretical knowledge presented by the course it also gave details of a dozen different industries which utilized

Secrets of Success

the services of chemists. During my studies, I was fortunate enough to bring to a successful conclusion a bit of original research work which was published in one of the journals of the American Chemical Society.

Due to my long hours at the grocery store, I was not able to study as much each day as I would have liked with the result that it took me a little more than three years to complete the course. However, shortly before I finished it, I was offered a position in the laboratory of a large flour mill at a starting salary of double the grocery pay which of course I was only too glad to accept.

The work is most agreeable, the hours reasonable, and I have plenty of time to study in my own laboratory on various research subjects. Occasionally I do analyses and work up formulae for commercial products which supplements my regular salary very nicely.

I am now studying French and German at home and expect to take up other studies in the future. I do not consider myself a financial success—yet—but I do know that I am advancing in the right direction at a much faster pace than had I not applied myself to a systematic course of study. It has taught me my chosen profession, has been a source of much pleasure, and has already paid for itself many times over.

What more could I ask of it?

—H. E. T., Salina, Kans.

HE WINS AGAIN

It must have been ten or twelve years ago that I saw the advertisement of a cartoon school in the columns of POPULAR SCIENCE MONTHLY. I had a regular job but was anxious to make some extra money as this was early in my married life and we needed many things. Answering the ad was one of the smartest things I ever did, for the course which cost me $25 has helped bring in, literally, thousands of dollars on the side.

I had been interested in prize contests to some extent, entering many of those announced in newspapers and magazines. I felt that if I had some knowledge of drawing—especially in cartooning—I could sketch pictures on my entries which would attract attention and bring out more forcibly the points covered by the text. The course answered my purpose exactly.

One of the earlier entries which I sent in for a contest right after finishing my studies carried three small cartoons illustrating the "copy" with the result that I won first prize, $250—ten times the cost of the course! Helped by my cartooning, I have averaged at least one prize every ten days, with total receipts ranging from $250 to $4200 annually. "Tops" was a prize of $2500.

Remember, all this has been done in EXTRA, or SPARE TIME, while regularly employed. Certainly it proves what can be accomplished if one really tries and I know of no better way to enhance one's chance than through home study. Just select a course in line with the work you want to do and if earnestly followed it is bound to bring results.

—F. G. D., Springfield, O.

ANYONE CAN ASSEMBLE THESE BAROMETERS

(Continued from page 72)

instrument results—one well worth making.

It is necessary that both ends of the brass tube be immersed in water at all times, so a little liquid should be added to the drain tube at the outset.

An imitation of the standard blown glass clipper-ship barometer is also possible. Supply the bottle with a bent tube and invert it, hanging it up with a ring fastened to the bottle bottom. As this style lends itself to decoration, the ingenious amateur weather observer can design ornamental or humorous jig-sawed "fronts" to hide the mechanism of the barometer. The writer worked out a decorative little corner bracket, consisting of a couple of leaf groups cut from plywood and nailed to the backs of three blossoms. Space left between the leaves houses the barometer tube, and cleats across the back hold it in position.

To make a similar housing, prepare a half pattern by drawing 1-in. squares and tracing the design through them. Transfer it to the wood with carbon paper. The flowers have their centers bored out and chamfered for peep holes, and the shelf is notched to receive the brackets. Paint the parts before assembling them, for in this way it is easy to flow on heavy, smooth coats of enamel. The lower leaf group is nailed to the front of the shelf, thus supporting the flower spray, and two half-round beads are bradded on to hide the nails. These can be painted after assembly.

For the barometer select a bottle 1½ or 2 in. in diameter. Insert a glass tube in the cork with about ¼ in. projection inside and 1 in. outside. Slip a short rubber tube over the outside end.

If the upper end of the registering tube is left wide open, the water will dry up rather rapidly, so it a good idea to reduce the opening to about 1/32-in. diameter by rotating it slowly in a gas flame until it melts and draws together. Install it in the flower support, connect it to the bottle with the rubber tube, and clamp the bottle to the "front" with two strips of tape tacked at the ends.

In fair weather the water should stand in the center of the lower blossom. If it does not, blow into the top of the tube to force a bubble of air back into the bottle, thus raising the tube level. Another way to regulate the barometer is to allow the tube to overflow, if it happens to, during a storm, and note the position it takes when good weather comes. In general, water showing in the upper flower means storm, and in the center flower, change.

Fasten the completed bracket in a corner with screws.

RESTORING USEFULNESS OF OLD PHOTO PAPER

WHEN photographic paper has become fogged because of its age, it can be restored to its former usefulness, although its speed will be cut about fifty percent, if bathed in the following: potassium permanganate, 5 grains; sulphuric acid, 30 minims; and water, 48 oz. Soak the paper in this solution for one minute and then transfer it to a solution of 20 grains sodium sulphite and 1 oz. water for one minute. The paper may be used in the enlarger at once or can be dried in the dark and stored.

BLACK VARNISH FOR CAMERAS

THE interior parts of your camera and plate holders can be touched up with an absolutely flat black varnish composed of 1 oz. sanderac dissolved in 5 oz. alcohol and then colored with a little dry lampblack. It dries in ten minutes and will not rub off or discolor.—I. C. L.

LIFE FROM TEST TUBES

(Continued from page 15)

three main ingredients—fats, carbohydrates, and proteins. Can the chemist put this concoction together?

Synthetic fats from petroleum are an accomplished fact. One such product, called "intarvin," has actually been used as a part of a diet for diabetics.

Carbohydrates, such as starch and sugar, offer the chemist a more difficult task. Nevertheless, a British experimenter, Prof. E. C. C. Baly of the University of Liverpool, was able to thrill the world of science a few years ago with the announcement that he had made them from carbon dioxide, the gas that is produced by burning carbon; a common mineral salt, potassium nitrate; and water! By treating these simple materials with ultra-violet light, he first produced a sugar closely related to, if not identical with, ordinary glucose or grape sugar. Other sugars and starches followed, so that today the artificial manufacture of these carbohydrates is perfectly feasible.

PROTEINS remained the stumbling block. Until now, experimenters trying out man-made food on laboratory animals have had to supplement the diet with a little natural meat or meat juice, or their charges would slowly starve to death. Would synthetic amino acids, which the animals themselves could transform into the needed proteins, fill the deficiency?

For months, University of Illinois research workers tried out one after another of these artificial protein-forming chemicals on white rats—and recorded failure after failure. Even when as many as seventeen synthetic acids had been compounded and supplied in the diet, to replace the natural protein of which the rats were deprived, some vital ingredient still seemed to be lacking. Then the experimenters added an eighteenth, an amino acid related to the butyric acid that forms when butter turns rancid. It was the missing ingredient! The rats throve on the new diet. For the first time in history, chemists had succeeded in preparing a synthetic food of the protein-forming type, containing no natural ingredients whatever.

In other words, all three of the principal ingredients of natural food can now be manufactured to order by chemists. If the necessary factors known as vitamins can be added—and there is good reason to believe that these will not offer the chemist insuperable difficulties—a complete meal, one hundred percent synthetic, can come out of the test tube!

STILL it remains for laboratory workers to duplicate the crowning feat of nature—to turn the protein-forming amino acids into the full-fledged proteins of animal and human tissue. Before a mechanic can assemble a steam engine, he must know the how and why of boilers, cylinders, and pistons—and so the chemist who would create a protein must lay the groundwork by finding out all that he can about the amino acids of which it is made. That is why the Los Angeles experimenters are testing their solubility in many liquids; studying their behavior in acids and alkalies; bombarding them with heat, light, X rays, and other radiations; studying their colors; testing their electrical properties with sensitive meters; and inspecting their crystal forms with microscopes. When the properties of each one are completely known, and all can be made to order, chemists will be prepared for the supreme attempt to put them together into products like those of nature.

Then, if some one of them succeeds, may come the most dramatic climax in the history of science. Will the test-tube creation be endowed with life? And if so, into what creatures might it be fashioned?

Today, no one can tell.

NOW YOU CAN FLY AROUND THE WORLD

(Continued from page 36)

gasoline consumption, head and base temperatures of two cylinders on each engine and oil temperature and pressure. His is a busy life from the time he takes off until he lands.

As you climb aboard the *China Clipper* at Macao, the flight engineer is adjusting all the motors so they will function in perfect unison when the pilot shoves ahead the throttles. With the big engines thundering, you gather speed. The slender hull rises in the water. A thousand feet, 2,000 feet, you roar across the bay. Then, the pilot eases back the elevator control and the great bird pulls itself free from the water and heads out over the Pacific. Your first stop is Manila, in the Philippine Islands, 700 miles away.

AT 5,000 feet, the pilot levels off and pushes a button, flashing on a light in the flight engineer's compartment.

"Carburetors in normal cruising," he speaks into a microphone

The engineer makes the necessary adjustments, touches a button that flashes on a light in the pilot's cabin and reports: "Carburetors in normal cruising, sir."

From full power, the engines have slowed down to normal cruising speed, about 1,800 revolutions per minute. During the trip from China to America, the engines will revolve a total of 26,000,000 times. There are 900 explosions of gasoline vapor in each of the fifty-six cylinders each minute, or a total of 181,-441,000 power strokes between Macao and San Francisco. The big ship can cruise at 157 miles an hour, and any three of the four power plants will keep it aloft, even when it is carrying a peak load.

You reach Manila that afternoon and at three o'clock the next morning you hop off for Guam over a 1,600-mile stretch of the Pacific. It is sunset when the great winged boat circles over this tropical island and slides down to a mooring for the night. At six the next morning, you are off again on a flight that requires the acme of navigating skill. Fourteen hundred and fifty miles away is the goal, Wake Island, a low speck of land only two and a half miles in width and four and a half miles long!

How can the pilot guide his ship through the sky with such accuracy? How does he find his way over 1,400 miles of water to this desolate dot of land in the mid-Pacific?

It is the navigating officer who keeps the boat flying on its course. Once every hour, day or night, he takes celestial observations, makes calculations, and determines the precise position of the craft. In addition, he checks up on the direction of radio stations broadcasting from the islands and from the mainland. To determine if side winds are drifting the ship away from its course, he uses an ingenious flask that is shaped like a miniature air bomb and contains a pound of aluminum powder.

ATTACHING his drift-indicating instrument to a window sill, he drops the flask into the sea. It shatters on striking, and the powder forms a tiny, glistening island that can be seen for miles. Speedily, he determines from the scale on his indicator the extent to which the ship is being blown sidewise.

This observation, however, will not reveal whether head winds are holding the craft back, or tail winds are speeding it along. To check up, the navigator determines where the boat should be fifteen minutes later, if there were no wind, and then determines her actual position at that time by radio bearing and celestial observation. The difference in positions represents the effect of the wind.

You see how well the navigation system works when, approximately fourteen hours after leaving Guam, your flying liner drops anchor at Wake Island. This previously uninhabited coral atoll, the home of millions of sea birds, will soon have a modern forty-five-room hotel, complete with baths, electric lights, and inter-room telephone service.

Your next hop is, in some ways, the queerest of all. On the 1,240-mile jump to Midway Island, you cross the International Date Line and lose a day. You leave Wake Island on Wednesday and arrive at Midway Island, the day before you started, Tuesday! Here, too, a modern hotel for aerial voyagers is under construction. So barren is the spot that, not long ago, a shipload of soil was carried all the way from the Philippines to make gardens possible.

Eleven hours after leaving Midway, the *China Clipper* ends the 1,380-mile flight to the Hawaiian Islands and you land at Pearl Harbor, near Honolulu. Twenty-four hours later, you are well out on the last, long leg to the California coast. This 2,410-mile journey begins in midafternoon and continues all night and half the next day. The captain and the first officer alternate at the controls at one-hour intervals

After the flight is started, weather conditions may change. Then, the Pan American experts at San Francisco show their skill in routing the roaring plane, sometimes hundreds of miles out of its usual course, away from the path of the disturbance into smoother and safer air.

WHEN you come in, at the end of seven days of ocean flying, a brilliant afternoon sun is shining. The Golden Gate, the ships at anchor in the bay, the city of San Francisco, the winding coast line spread out below you as you soar toward the landing place. Once more, you are on the same continent from which you started. The trip from Macao has cost $1,000 and, taking for granted you have made connections throughout the trip, your total time from Lakehurst is nineteen days.

A few hours later, in a three-mile-a-minute Boeing monoplane, you are streaking eastward in an overnight hop to New York on an American air line. The Sierras, the Rockies, the Mississippi Valley, the Alleghenies pass below in the darkness and you sit down at the Newark airport, a few miles from your starting point, just as commuters are catching their morning trains for New York. You have circled the globe on regular air lines, traveled 25,292 miles, passed over nearly thirty countries, seen Europe, the Far East, the South Seas, with an elapsed time of twenty days and at a total cost in fares of $2,465.

The story of such a journey, but a single generation ago, would have read like a page of fantastic fiction. Now, it is entirely within the grasp of present-day travelers. High-speed Zeppelins, multimotored airliners, clipper ships of the sky have made it possible. The Phileas Fogg of 1936 can buy his tickets in advance and can make his air-line circuit of the globe in comfort.

BLOOD OF ANIMALS USED TO COMBAT HUMAN ILLS

ANIMAL blood, transfused into the blood stream of a human patient, will aid the body to fight off certain diseases, according to a recent report of experiments conducted by Soviet scientists. Blood is extracted from goats and bulls, and is specially treated to make it suitable for injection into human veins. Transfusions are given to patients every five days in gradually increased amounts and have resulted in positive benefits in many cases. Further studies are being made in the hope that transfused animal blood may prove valuable in the treatment of a variety of diseases.

WHAT TO DO WHEN YOU STICK IN THE MUD

(Continued from page 56)

"I wish I could have you with me all the time," Gillespie smiled. "I have to do quite a lot of visiting on these back roads and I dread it in the spring. I'm always getting stuck. It's humiliating to have to ask for help so often. Wouldn't it be a good idea if I procured a number of potato sacks and kept them in the car? I have never seen such awful mud as we're having this spring."

"WITH all the heavy rains we've had lately, that's not surprising," Gus commented. "A potato sack, or any piece of heavy burlap or rough cloth, is about the most useful thing you can have handy for getting out of mud—and that goes for sand too. You can store some of 'em under the seats, and stuff the tool compartment with several more. Besides being useful when you're stuck, they keep the tools from rattling around."

"Will burlap always get you out?" Gillespie asked.

"I should say not!" Gus replied, emphatically. "A potato sack is useful only when there's something for the wheels to get hold of. If you get bogged down to the point where the rear axle, and maybe other parts of the under gear, are resting on the mud, then enough of the weight is taken off the tires so they won't have traction even on burlap."

"What's to be done in such a case, short of hiring a team of horses or getting some other driver to pull you out?" Gillespie inquired.

"Depends on how you're bogged down," Gus replied. "Like enough, with the crowd that's coming to this wedding and the state of the ground right now, we'll have plenty of cars stuck in all sorts of ways there beside the church. Keep your eyes open after the ceremony and watch how we get 'em out."

Gus's forcast proved accurate. When the crowd thronged out of the church to drive to the bride's home for the reception, they had a bad time of it. The first car attempting to drive out of the parking area skidded around and sank its rear wheels hub-deep, in such a position that it blocked any other cars from moving out, and at such an angle that no car on the road could exert a useful pull on it.

GUS fished his jack out of his tool kit, and also several blocks of wood of various sizes. "We'll have to raise it up so as to get some rocks under those wheels," he observed, as he placed a short piece of board beside one of the rear wheels. On top of that he piled wooden blocks until the business end of the jack reached the upper side of the rim.

"Screw jacks are best for this kind of a job," he said to Gillespie, who was carefully watching the procedure. "They apply the pressure smoothly, and there's less chance of having the blocks slip. As soon as we get it up far enough, we can slip some loose rocks or a piece of board under the wheel to hold it up while I get the jack down under the edge of the hub to give it another lift."

"But there's no hub sticking out of these modern wheels," Gillespie objected.

"So we tip the jack and wedge it against the hub at an angle, this way," Gus went on, suiting the action to the words. "Of course, there's always a chance that the rear of the car will slide sideways. But if you're careful, that won't happen. Even it it does, it just means starting over again after wedging a block under the side of the opposite wheel to keep it from slipping again. Usually, the car is tipped *(Continued on page 121)*

WHAT TO DO WHEN YOU STICK IN THE MUD

(Continued from page 120)

enough from the wheel bogging down so that there isn't much tendency to slide, anyhow."

Getting this car out of the way allowed the majority of the other cars in the parking space to drive out. Some, who found it hard to get going, pulled attachable chain units out of their tool kits; one old fellow, with a heavy, old-fashioned car, yanked a coil of rope from a running-board tool kit and wound a section of it around and around each rear tire.

"That appears to be an excellent idea," Gillespie said, calling the rope-winding stunt to Gus's attention.

"DOES the business in fine style in mud and sand, but it certainly plays the devil with the rope. I wouldn't recommend it except in an emergency," was Gus's comment.

"Here's another way to use rope," Gus suggested, as he observed a young fellow vainly trying to "rock" his rear wheels out of a slippery gully in the mud. "That fellow's front wheels are on good, solid ground. If we tie one end of a piece of rope to one of the rear wheels, halfway up the forward side of the tire, and the other end to the front wheel on the same side, not quite halfway up the forward side and do the same to the other two wheels, then he'll have a four-wheel drive for a half revolution of the wheels."

The young fellow readily accepted the suggestion, and Gus applied two lengths of rope in the manner he had described.

"Now, mister," he said, "let the clutch in gently, and just ease her forward about two feet—no more. That's going to get you out of the gulley, and we can take the ropes off."

"Quite an excellent arrangement," Gillespie commented as the car pulled out of the gully with apparent ease.

"Sure is," Gus agreed, "and if we had nothing but four-wheel-drive cars it would be nearly impossible to get stuck in any kind of mud short of a regular bottomless swamp."

"I wish I had such a car," sighed Gillespie as he and Gus climbed into the car to go on to the reception.

"I can suggest something even better than that for tough going," said Gus.

"Better than a four-wheel-drive car?" exclaimed Gillespie. "That would be wonderful. What is it?"

"Buy yourself an endless-tread tractor!" Gus chuckled.

LAMPS PRODUCE VARIETY OF EXAMINING LIGHTS

BECAUSE fabrics appear a slightly different color in daylight than they do under artificial light a British concern has installed a room where yard goods for dresses can be viewed under practically any type of natural or artificial illumination. A number of different sets of special lamps reproduce the varying colors and intensities of light rays from the sun, gas burners, electric lamps, candles, and other light sources.

ALL U. S. ARMY PLANES NOW RADIO-EQUIPPED

NO COUNTRY now surpasses the United States in radio equipment for its war planes, Signal Corps experts declare, following recent installation of the latest apparatus for radio communication and navigation in all of the Army's 1,150 fighting craft.

MILE-A-MINUTE PIGEONS

(Continued from page 28)

To speed birds into the traps as soon as they settle down, many trainers "walk them in" rapidly by means of a short pole. However, there is always the danger that the high-strung bird may become frightened and take to its wings before it is safely caged.

One of the latest developments in the homing-pigeon world is the use of these mile-a-minute birds as carriers of news films. Several metropolitan dailies have put pigeons on their staffs. One New York newspaper uses them to bring undeveloped films of photographs of celebrities from incoming steamers. Almost before the liners dock, the papers containing the pictures are on the street. Similarly, pigeons carried pictures of the Rose Bowl football game between Stanford University and Southern Methodist University last fall, covering the distance between Pasadena and Los Angeles, Calif., in record time. Carrying light-proof aluminum capsules attached to their legs, the birds winged their way over a maze of buildings and with unerring instinct alighted on the one that was their destination.

HOW did they find their way? How do these marvelous birds cover vast stretches of country they have never seen before? What guides them through the sky?

In answer to those questions, science is silent. The homing instinct is still an enigma of nature. One Belgian investigator advances the theory that the pigeons fly in a state of self-hypnosis. Another expert declares they have eyesight so superior to ours that they see distant details that humans miss and so follow a trail of tiny landmarks. Other scientists believe they are guided by the magnetism of the earth, following lines of magnetic force as a mail-plane pilot follows a radio beam.

Not long ago, a fascinating series of experiments revealed that radio affects the homing ability of pigeons. Research men released flocks of the birds near a broadcasting station while it was on the air, and again when it was not operating. When no radio waves were given off, the pigeons headed away for home in twenty seconds. When the station was on the air, however, it took them as long as three minutes to find their direction. Once, 169 birds were liberated at the same time. More than half of them, after repeated failures to find their direction, alighted near the station from which the radio waves were coming.

Just how the homing pigeon finds its way along the invisible skyways remains an unsolved riddle of science. But the speed and skill of these fleet-winged birds is providing thrills and pleasure for an increasing number of Americans.

ELECTRIC BELL RINGS FOR NEARLY A CENTURY

A CURIOSITY among historical electrical exhibits at an Oxford, England, museum is an electric bell that has been ringing continuously for ninety-six years. Set in operation in 1840, the device is still going strong and gives every indication of rounding out the century mark. The bell has never needed repairs, and is declared to be "the nearest approach to perpetual motion." Its current comes from an early form of battery known as a voltaic pile, consisting of thousands of disk-shaped elements arranged in a stack.

SEALS TO WEAR STRIPES FOR MIGRATION STUDY

SOVIET scientists, during a projected expedition, will seek to catch 400 white seals, paint them barber-pole fashion with black stripes, affix metal tags to their tails, and release them so that their wanderings may be traced. The seals appear in the White Sea from February to April and vanish for the rest of the year.

CHEMICAL STUNTS WITH THREE MAGIC METALS

(Continued from page 51)

enough to scorch the paper of the box lid, leaving tracks that record the movement of the large globule and the smaller ones that break off from it. If the antimony is simply melted and dropped upon the box lid, it will smolder for about a minute, emitting white smoke and leaving a trail of the oxide behind it. White fumes of the oxide are also produced if antimony is heated upon a charcoal block with a pointed flame, such as that of a blow-

Bismuth, melted in a crucible and then allowed to cool, provides crystals for examination

pipe. Finely powdered antimony or bismuth burns rapidly if it is thrown into a Bunsen flame, and a pinch of antimony tossed upon molten potassium nitrate that you have heated in a tin-can lid or a crucible takes fire with a shower of sparks.

Antimony and bismuth, like iron, decompose water when heated red-hot. They react chemically when heated with sulphur or when dropped into a vessel of chlorine gas, producing heat and sometimes light. Sulphides and chlorides of the metals are formed as a result.

When you try to dissolve antimony chloride or bismuth chloride in water, you will notice that a white precipitate is always produced unless a drop or two of hydrochloric acid is also added. The acid dissolves the white precipitate, which is a basic salt of the metal being used and is known as an oxychloride. Nearly all antimony and bismuth chemicals produce precipitates of this kind unless enough acid is present to keep the oxychloride in solution.

YOU can apply this fact in an effective little chemical trick. Make a solution of the chloride or nitrate of either antimony or bismuth, using just enough acid to give a clear, waterlike liquid. Hold half a glassful of this solution under a faucet, and add enough water to fill the glass. The contents change from "water" to "milk" as the white precipitate of oxychloride appears, due to the reduced concentration of acid. To one who is not in on the secret, it looks as if you drew a glass of milk from the water faucet.

A peculiarity of bismuth oxychloride is that it is somewhat photosensitive, turning gray in sunlight. A chemical difference between the oxychlorides of antimony and bismuth can also be shown. Adding a few crystals of tartaric acid will cause a precipitate of antimony oxychloride to redissolve, while a precipitate of bismuth oxychloride is unaffected. This may be used as a test to distinguish between antimony and bismuth

Place a strip of iron or zinc in a solution of an antimony or bismuth salt, to which a little acid has been added to prevent formation of the oxychloride, and metallic antimony or bismuth will be deposited upon the foreign metal. A strip of copper placed in a solution of antimony chloride, which has been acidified with strong hydrochloric acid, becomes covered with a curious violet-colored mass. This is known as Reinsch's test for antimony.

Antimony may *(Continued on page 124)*

CHEMICAL STUNTS WITH THREE MAGIC METALS

(Continued from page 123)

also be detected by a method closely resembling Marsh's test for arsenic, described in an earlier issue (P.S.M., Dec. '34, p. 56). Hydrogen gas, generated in a flask from zinc and sulphuric acid, is led through a drying tube containing anhydrous calcium chloride and then through a horizontal piece of glass tubing about eight inches long, which is gently heated with a small flame during the experiment. After hydrogen has been generated for five or ten minutes to clear the apparatus of air, admit the solution to be tested for antimony to the generating flask, through a thistle tube or a separatory funnel.

ANY antimony that is present in the chemical will combine with a part of the hydrogen, forming a gaseous compound of antimony and hydrogen called stibine. When the stibine gas reaches the heated outlet tube, it will be decomposed, and a metallic mirror of antimony will be deposited upon the inner surface of the glass. If the gas issuing from the outlet tube is ignited, a cold porcelain dish held in its path will also receive a deposit of antimony. The zinc used in this experiment, if not of high purity, may contain some arsenic, and this will produce a deposit of similar appearance. The two are readily distinguished, however, by a simple test. The antimony stain will not dissolve in a solution of bleaching powder, while the arsenic deposit will. Try the test first upon a compound that you know contains antimony, for practice. If the gases are not being burned at the end of the outlet tube, the room should be kept well ventilated while you are performing this experiment.

Stibine, formed in the test just described by the combination of antimony and hydrogen, is known as a hydride. The gas has been detected issuing from storage batteries while they are being charged, as a result of the combination of hydrogen liberated during the charging process with antimony present in the lead plates of the batteries.

Melt some bismuth in a crucible, and you can obtain a sample of the crystals produced by this metal. Let the molten bismuth cool until a hard crust forms on the surface. Then break the crust with an iron rod and pour out the remaining liquid. The crystals will be found adhering to and covering the inside walls of the crucible.

Antimony and bismuth form a variety of peculiar and interesting alloys with other metals. One, containing antimony and copper, has a beautiful purple color! Another, consisting of bismuth, tin, and lead, will enable you to "silver" the inside of a flask or a bulb blown from glass tubing.

MELT four parts of lead, by weight, in a crucible; then add six parts of tin. When all is molten, stir in ten parts of bismuth. A piece of glassware in which the resulting alloy is placed, gently heated, and swirled about, will receive a silvery inner coating and will make an interesting exhibit to add to your chemical museum.

Though their names may be unfamiliar to the layman, antimony and bismuth have a number of commercial uses. Type metal is made of about seventy-five parts of lead, twenty of antimony, and five of tin; unlike most substances, it expands upon solidifying, thus giving a clear impression of the type mold. Babbitt metal and Britannia metal are other alloys containing antimony. Bismuth alloys, which melt at remarkably low temperatures, are employed in automatic sprinkler systems for fire-fighting. Salts of bismuth are employed medically, as already noted, and are also used in the manufacture of hand lotions, cosmetics, artificial pearls, porcelain enamels, and certain paints.

OIL-WELL SURGEONS PERFORM AMAZING FEATS

(Continued from page 23)

scalpel-like, so it can be removed piece by piece.

Now and then, a broken pipe becomes crowded far back into the formation when drillers vainly try to remove it. Tapered taps are lowered to screw into the open end in hope of engaging the threads; or an "overshot" is dropped to grip the stub with the teeth concealed within its cylindrical barrel. Perhaps the crew may angle for the "fish" with a harpoonlike spear; if other stratagems fail, a wall hook—an instrument somewhat resembling a gigantic can opener—is lowered. As it is slowly rotated, crafty fingers insert themselves behind the broken pipe, pulling it back into the hole where it can be removed by other grappling instruments.

FOR recovering small things such as pipe joints or collars that have slipped into the hole, the surgeons have a variety of queer-looking instruments. Chisel-like tools chop obstructing steel objects into small pieces, which may be captured in metal baskets and raised to the surface.

A group of oil-well surgeons once was baffled by a California well which persisted in strangling itself. Oil flowing upward brought sand which rose until it neared the surface where the casing widened and the pressure dropped off. Here the grains accumulated, forming a "floating bridge" or lump which soon obstructed all flow. Efforts to drill out this plug were futile, for the weight of the bit on the lump acted as a piston, building up a heavy gas pressure. When the bridge was penetrated, this suddenly released pressure sent tools flying upward in a tangled skein of steel.

The case seemed hopeless, but a young engineer had an idea. He tinkered in his workshop until he had devised an instrument like a double-boiler kettle, with telescoping upper and lower compartments. After the device had been lowered, a sudden tug expanded the upper chamber, sucking the contents of the lower compartment upward. To fill the vacuum thus created, loose material beneath was drawn into the bottom of the kettle, where it was trapped by a valve. Like a "plumber's friend" working upon a clogged kitchen sink, the tool sucked up the accumulated settlings in the plugged well until oil flowed again.

Since then, the young inventor's suction bailer has been used in many holes clogged by sediment. Producing wells in the Oklahoma field have been found filled with sand for a third of their 6,500-foot depth. From such wells the bailer commonly brings up a variety of objects ranging from bits of steel and wire to sticks and chunks of rock. Often, when opened, it is found to contain what seems to be a basketful of eggs. These objects are fragments of extremely hard rock, worn smooth and egg-shaped by constant churning in the flow of fluid at the bottom of the hole. They act as virtual roller bearings upon which the drill spins without making further progress. Extracting such bodies from the throats of sick wells is just one of the deft bits of surgery performed by the oil-well expert.

MEMORY BEST AT AGES ELEVEN TO FOURTEEN

WHAT past event is most vivid in your memory? According to a recent statement by Dr. J. Alison Glover, London physician, people recall most clearly the things which happened when they were between eleven and fourteen years old. Although he admits that there are many exceptions to this rule, Dr. Glover believes that educators should take the fact into consideration in the teaching and handling of children at the eleven-to-fourteen-year period.

Guarding Workers Against the Demon of Dust

(Continued from page 39)

particles in a given size group are recorded on a counting machine. The ruled squares of the screen make measurement easy, each centimeter representing a distance of one micron on the slide. A micron is a thousandth of a millimeter, which is equal to about one-twenty-five thousandth of an inch.

With the microprojector, ruled screen, and ingenious system of remote control, a man can do in fifteen minutes a dust-counting job that formerly required three hours, and do it much easier and better.

And so these scientific sleuths carefully work out the criminal records of various dusts. When these records are complete, they answer a number of pressing questions. They reveal whether a dust hazard really exists—whether the men working in the factory where the samples were collected are in danger of contracting some lung disease. If a danger does exist, knowledge of the facts enables the Bureau of Mines investigators to recommend remedies. Perhaps changes can be made in the way the work that causes the dust is done. Maybe the ventilation can be improved so as to remove the danger. Or it may be possible to use a water spray to settle the dust. Finally, if no other way can be found, the Bureau of Mines recommends the use of approved breathing masks.

THE testing of masks to see if they meet standards set up by the laboratory involves equipment every bit as fascinating as the microprojector. Masks are tested as to the materials they will exclude from the air breathed, the rate at which they clog up and make breathing difficult, the snugness with which they fit about the face, their comfort, and other properties essential to good performance.

A mask also may be used for protection against fumes or mist. Fumes are products of various metals, usually such compounds as oxides or carbonates, and often are highly poisonous. Mists are composed of liquid particles, and are met with in spray painting, chromium plating, and similar operations. Frequently, combinations of dust, fumes, and mists are encountered.

The most satisfactory respirators are essentially mechanical filters having screens of one kind or another through which the air to be breathed is drawn. Particles in the air become enmeshed in the filtering material. There are, also, respirators which have individual air supplies, an example being the hoods used by sand blasters.

The dust investigators in Pittsburgh, when testing a dust mask, are interested principally in what gets through the filters. If the quantity of dust, mist, or fumes passing through is sufficient to cause trouble, the device is, of course, unsafe. By various methods, such as subjecting animals to known concentrations of dusts, safe limits have been established; all masks approved must conform to these limits.

Most of the mask tests are performed by a sort of robot that breathes air through the filter pad and traps dust particles in a glass "lung" or respiratory system. This machine also measures the resistance to air flow caused by the filter unit. Incidentally, if you use a respirator, you will be interested to know that the filter pad is least efficient when it is new, and most efficient when partially clogged by trapped particles.

If you were to drop into the Bureau of Mines dust laboratory while a dust test on a respirator was being run, you would find that finely divided silica, the same material that causes silicosis when breathed in sufficient quantity, is employed in the trial.

SILICOSIS, incidentally, is not a new disease. It was known to the early Greeks, and has been giving trouble ever since. Silica, or silicon dioxide, is a very hard, flinty substance which can be divided into extremely small particles. When breathed into the lungs, it lodges in the tissues and poisons them. This poisoning is believed to be mainly chemical. In an effort to test this assumption, finely powdered aluminum oxide and other dusts have been breathed by experimental animals. Although these dusts lodged in the lungs just like silica, and are practically as hard and sharp as silica, they did not cause the disease known as silicosis.

But to get back to the dust-breathing robot: Silica dust is used in it because the particles can be made extremely small, the majority of them less than a micron, or one twenty-five thousandth of an inch, in diameter. This dust, made by mechanical grinding and screening, is placed in a long, glass tube. Projecting down into this tube is a smaller one, at the lower end of which is a spirally grooved fitting and a series of prongs supporting a ring-shaped knife that breaks up the silica column. The smaller tube is connected to the intake of an atomizing chamber or aspirator. A suction fan, like that in a vacuum cleaner, draws air through an air cleaner and through the atomizing chamber where it picks up silica dust, and exhausts it into a large glass-walled room. Paper baffles in the room control the flow of dust-laden air currents. From this mixing chamber, pipes lead to a similar room below.

By the time the air gets into the second chamber, it is uniformly laden with silica dust. A rough check on the concentration is made by a beam of light that shoots across the chamber and strikes a photo-electric cell connected to instruments that indicate the intensity of the light beam.

In one side of the lower dust chamber is a little door with a hole in it. Through this hole projects one end of the glass "lung." This lung is an L-shaped glass tube a yard or so long. One end has a cone-shaped opening into which fits a glass support carrying the mask to be tested. The mask or filter unit is sealed to the glass with wax. The other end of the lung, the short leg of the L, is connected to a vacuum pump. When air is sucked through it by the vacuum pump, the filter removes most of the silica dust. The amount that passes through determines the efficiency of the filter.

The dust that does struggle through the filter is trapped electrically. Immediately behind the mask holder connection, inside the glass lung, is a smaller glass tube that has, extending along its center, a nichrome wire. Surrounding this tube is a cylindrical metal screen. The wire is connected to one terminal of a 30,000-volt, sixty-cycle transformer, similar to those used for operating neon signs; the screen is connected to the other terminal. Dust particles are unable to pass through this strong electrostatic field, and are deposited on the small tube. This tube is carefully cleaned and weighed before being inserted into the device; and is again weighed at the end of the test, the weight difference representing the amount of dust that passed through the filter.

FOR testing the resistance of a mask to fumes, poisonous lead vapor is generated by burning gas to which has been added a small quantity of liquid tetraethyl lead—the same stuff that is put into gasoline to keep your car's motor from knocking. Mist tests are made with three different materials—chromic acid mist produced by standard chromium-plating equipment; wet silica dust that simulates the solutions sprayed on bathtubs and the like in vitreous enameling, and lead-paint spray like that encountered by painters who use spray guns. Sand-blasting helmets are tested under actual sand-blasting conditions.

Finally, masks are checked to see whether they fit the face snugly. Volunteers with different types of faces put on sample masks, and then remain for a time in an atmosphere heavily laden with coal dust; or else stand in front of a jet of coal-dust-laden air. Where the masks fit snugly, the covered portions of the face remain unblackened; where it does not, the coal dust is plainly visible. Inspection of nose and mouth discharges and of the nasal passages of persons employed in such tests is considered a reliable index of the quantity of coal dust breathed.

As these Bureau of Mines sleuths solve each new dust mystery, more and more scientific information is added to the criminal records of dust, mists, and fumes, and the lives of industrial workers in countless fields of work are made safer. Their research is taking the dust out of industry.

Roller Skates Have Tractor Treads

LOOKING like a pair of toy army tanks, roller skates invented by a Japanese school teacher are fitted with endless treads like those used on tractors. This novel feature is said to make it possible for users to skate over rough surfaces that would stop conventional skates.

WHO SAYS THERE'S NO DIFFERENCE IN GASOLINE?

HERE'S THE DIFFERENCE
in 37 seconds

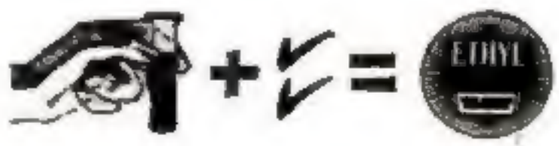
BEWARE a "pinging" sound this summer when you "step on the gas" for pick-up, or hills. It is your engine's way of saying: "I feel hot weather, too. I'm *losing* power, *wasting* gas and *overheating*. Give me better gasoline."

KNOCK is the name of that warning "ping." It occurs when a gasoline breaks down (burns too quickly) under the heat of a modern high compression engine.

Cars built in recent years have high compression engines. And in summer the knocking evil is at its worst because hot weather increases engine heat.

THE CURE—and preventive—of knock is better gasoline. That is why most oil companies now improve gasoline by adding anti-knock fluids (containing tetraethyl lead) made by the Ethyl Gasoline Corporation.

They recommend, as their *best* fuel for summer driving, special gasoline sold at pumps marked "Ethyl."



YOU GET at the "Ethyl" pump:

- *Enough anti-knock fluid to stand up under the highest engine compression on the hottest day.*
- *All-round quality that is* double-checked—*by oil company and the Ethyl Gasoline Corporation—at the refinery and at the pump.*

DOWN TO 2¢ a gallon over regular gasoline—and high above it in anti-knock (high compression) value.

Give your car the *coolest* fuel this summer. Avoid the evil of knock, with its power loss, gasoline waste and overheating. Get more power from each gallon of gasoline you buy!...

NEXT TIME GET ETHYL